Foreign Agricultural Economic Report No. 11

MAN LAND & FOOD

ing ahead at world food needs

Department of Agriculture / Economic Research Service / Regional Analysis Division

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By Lester R. Brown

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PREFACE

The purpose of this study is to add perspective to the world food problem. Its scope and complexity are such that comprehension is difficult. The problem itself is not new; it has always existed. It is the magnitude of the problem that has changed. Two factors are responsible. First, the number of people in the world is increasing so rapidly that it now seems quite likely that the increase in world population between now and the end of this century, only 37 years hence, will equal or exceed the current population. Secondly, this is occurring at a time when the amount of new land suitable for cultivation is rapidly diminishing.

In spite of the fact that diets have improved greatly over the past several decades in the developed world, little improvement has occurred in the less developed regions. Because vastly greater numbers of people now live in the less developed regions where nutrition is deficient, a greater number of people, and perhaps even a greater share of the world population, is suffering from an inadequate diet than at the beginning of this century.

By virtue of centuries of persistent effort, man gradually enlarged the world food supply until by 1960 it would support 3 billion people, though not all of them adequately. Up until about this time, man was able to augment the food supply largely by moving to unsettled areas and bringing new land into production. This is undoubtedly the easiest way, for it is largely when this approach is exhausted that man has turned to the alternative method of raising yields.

It has now become necessary to turn to the alternative method--to match population growth with yield increases. Closely associated with this shift toward rising yields for additional output are two very significant facts. First, massive applications of capital will be needed to raise yields--capital must be substituted for land. Secondly, this change in the method of achieving the additional output implies drastic changes in technology, especially in the less developed regions.

This analysis, then, seeks to assess the magnitude and direction of the effort which must be made during the remaining four decades of this century if the projected population is to be sustained.

This study owes much to the administrative guidance of Dr. Quentin West, Deputy Director of the Regional Analysis Division. Charles Gibbons, Statistician of the same Division, supplied many useful suggestions, particularly in the latter stages of development. The author also benefited from the uncommon degree of interest demonstrated by Mrs. Edith Allen who compiled the data.

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SUMMARY

The world food problem is closely associated with a rapidly developing population crisis. The food problem is two dimensional. It is partly a production problem, partly a distribution problem. Food supplies in the developed regions are abundant and steadily rising on a per capita basis. In the less developed regions, supplies are inadequate and although grain output per capita is now rising it is still below prewar.

The distribution aspects of the food problem give little evidence of immediate improvement. Population in the less developed regions, now totaling 2.1 billion, is expected to reach nearly 5 billion by the end of the century. If the expected addition of about 3 billion materializes, the less developed regions will need to develop an additional food production capacity equal to current world capacity.

Land, the most important ingredient in the agricultural production mix, is in limited supply. Of the earth's land surface of 33 billion acres, less than 3 billion acres actually produces crops in any given year. Ninety-three percent of this area produces edible crops; 71 percent of the total is used to produce grain. Much of the 7 percent in nonfood crops is planted to fibers, mostly cotton.

All of the world's seven geographic regions expanded grain output from 1934-38 to 1960/61. Not all regions, however, made per capita gains. Grain output per capita, an indicator of overall per capita food output, trended strongly upward in the developed regions, going from 470 to 594 kilograms. In the less developed regions, however, average per capita output declined, dropping from 225 to 218 kilograms. The grain area expanded in all regions except North America and Western Europe where it declined 4 and 5 percent, respectively. The per capita grain area, however, declined in each of the seven geographic regions.

Food consumption patterns vary widely between regions particularly where income variations are great. The share of total calorie intake deriving from the consumption of starchy food varies from 24 percent in North America to 74 percent in Asia. Comparable regional variations for livestock products range from a low of 4 percent in Asia to 35 percent in Oceania.

Man's principal sources of food energy are rice and wheat; these two foods supply 21 and 20 percent respectively of total calorie intake. All grains combined supply 53 percent of the total. Grains consumed indirectly in the form of meat, milk, eggs, and animal fat account for a substantial part of the remaining 47 percent.

The world trade pattern in all grains considered aggregately has changed drastically since prewar. During the 1934-38 period Latin America was the leading regional net exporter, exporting an average of 9 million tons net per year or 37 percent of total net regional exports. Comparable figures for North America were 5 million tons per year or 22 percent of net regional exports. All regions were net exporters of grain except Western Europe. By 1960/61, however, only two geographic regions, North America, and Oceania, remained substantial net exporters. North American net grain exports had reached 39 million tons or 86 percent of the total. Joining Western Europe as net importers were each of the three less developed regions. In 1934-38 the three less developed regions had combined annual net grain exports of 12 million tons. By 1960/61 these same regions were net grain importers, with combined net imports of 18 million tons. The Communist Bloc, exporting 4 million tons annually on a net basis prewar, was importing 1.1 million tons in 1960/61.

Projections of net regional grain trade flows show a growing dependence of all the current net importing regions on North America and Oceania. Net grain exports of North America are projected to 64 million tons in 1980 and 94 million tons in 2000.

Factor productivity varies widely between regions. Average regional grain yields per acre vary from 318 kilograms in Africa to 927 in North America. All regions have raised yields since prewar but gains in North America have been most pronounced. Variations in grain output per capita of the farm population are much greater than those for the total population. The 1960/61 per capita output for the farm population in Africa, Asia and Latin America was 294, 377, and 389 kilograms respectively. North America led all regions in this respect with 9,909 kilograms of grain per capita. Eastern Europe and the Soviet Union, at 1,360 kilograms per capita in 1960/61, was still far below the prewar North American level of 3,303 kilograms.

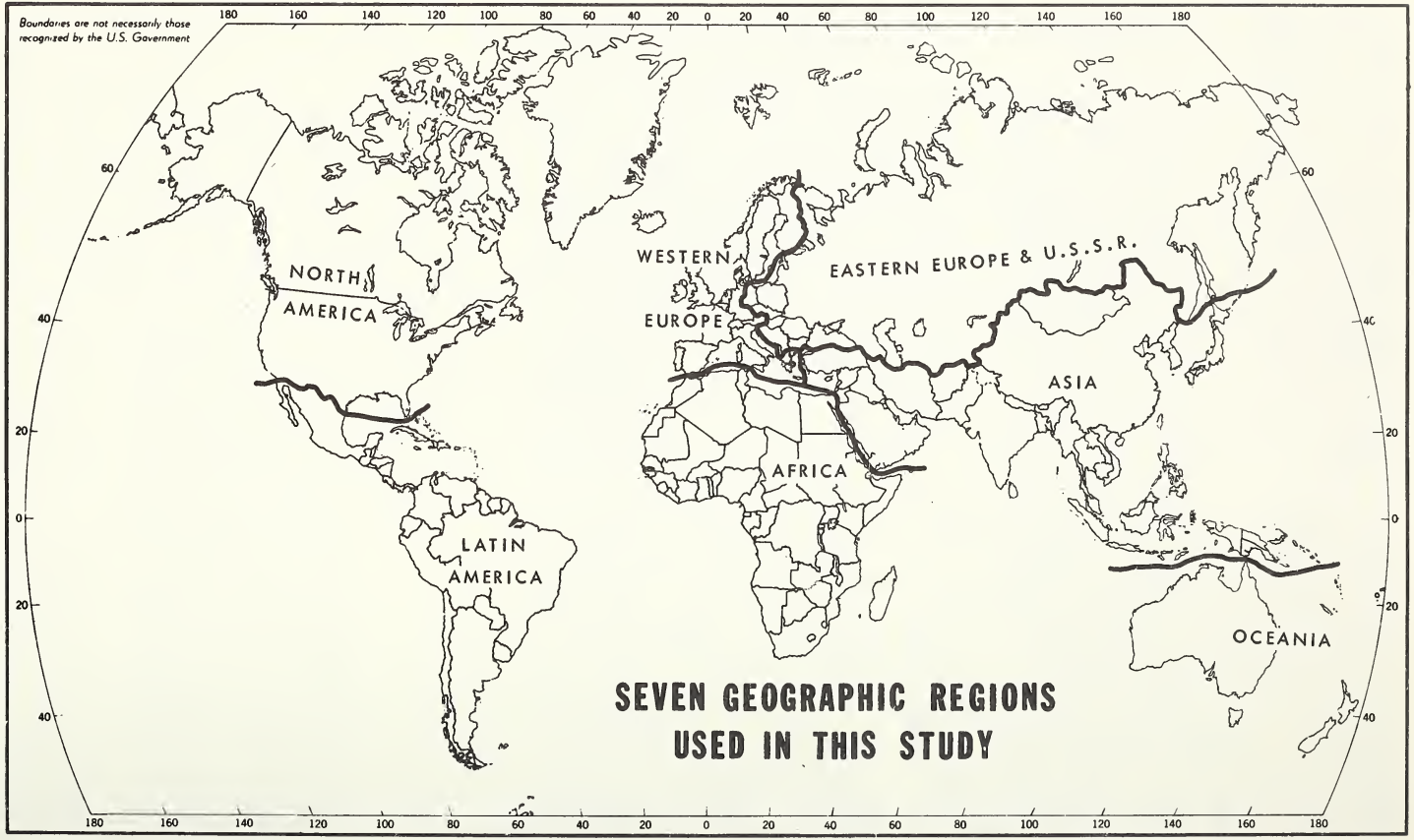
World food output must expand at a faster rate in the years and decades ahead than ever before in history if the projected numbers are to be sustained. There are two principal ways of achieving this greater output--expanding the cultivated area and increasing yields. Up until 1950, expanding the cultivated area was the chief means of expanding output. Since 1950, however, improving yields has been the principal factor. During the past decade, rising yields accounted for four-fifths of the production increase and additions to the cultivated area one-fifth.

As the world looks more and more to rising yields for future increases in the food supply, capital input requirements will climb rapidly. Stated otherwise, capital will be substituted for land in the

production mix. Increasing the intensity of cultivation of the limited land supply implies more multiple cropping and irrigation and the greater use of fertilizer, pesticides, improved seeds and machinery. The use of more fertilizer in combination with other improved technology will undoubtedly be the single most important means of expanding output.

To achieve a reasonable estimate of future inter-regional grain flows, production requirements and hence requirements of fertilizer, some arbitrary grain production projection models were constructed. Model II, the only model yielding acceptable results from a nutritional standpoint, shows that the current fertilizer consumption of 5 million tons in the less developed regions will need to expand to 33 million tons in 1980 and 86 million tons by the year 2000.

It now appears that the U.S. agricultural sector is destined to play a leading role in future efforts to expand the world's food supply. The extent to which the United States supplies "food or fertilizer" will vary with individual countries. The population/land relationship within a given country will influence production costs and should help determine the relative importance of direct food shipments versus the provision of capital and technical assistance needed to produce the additional food. Although the projected flow of food from North America to the less developed regions in future decades will be much larger than at present, it will be rather small when compared to the growing needs of these regions. Even so, this food will be strategically important in regions generally characterized by diets scarcely above the subsistence level.



U.S. DEPARTMENT OF AGRICULTURE

NEG. 2470-63(10) ECONOMIC RESEARCH SERVICE

MAN, LAND, AND FOOD
Looking Ahead at World Food Needs

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Chapter I.--ORGANIZATION OF STUDY

The Right Questions

This study is essentially a response to certain basic questions, the answers to which will influence U.S. agricultural and foreign policy in the years ahead. The questions:

How fast is world population now growing? How does this rate compare with past and projected future rates of growth in each major region of the world? How do rates of natural increase compare between the developed and less developed regions of the world? How will the regional distribution of world population appear in 1980 or 2000 as compared with 1960?

The key question with regard to land is not how much can the cultivated area be expanded but at what cost and how rapidly can this be accomplished. In what countries is the cultivated area expanding and in how many countries is it now declining? In which regions of the world are food production gains occurring more as a result of expansion of the cultivated area and in which as a result of higher yields? And the closely related question, in what regions is population growing faster than cultivated area? What are the future prospects with regard to these relationships? If capital must be substituted for land in the production mix in the less developed, low income countries, where is it coming from?

What is the nature of regional and national diets? Have per capita food availabilities in the less developed countries improved or deteriorated over the last quarter century? Which countries have nutritionally deficient diets and what is the nature of the deficiency? How and at what cost may these deficiencies be eliminated? To what extent will rice eaters be converted to wheat eaters as need grows faster among the rapidly growing rice-eating

populations while short-run production potential remains relatively much greater in the wheat-growing regions?

How much has output of grains increased over the past quarter century in each geographic region? Are per capita trends in grain output by region rising or falling?

What are the long-term trends in world food trade by region? How are regional differences in population growth rates, population density, and level of income affecting the inter-regional flow of foodstuffs? What forces underlie these quarter century trends? How will the world food trade pattern appear in 1980 or 2000 if these general trends are projected?

How do the supplies of agricultural land, labor, and capital compare between the developed and less developed regions? To what extent has a tropical agricultural technology developed? Is the current agricultural effort in the less developed countries adequate? What is the nature of the rising cost curve associated with attempting to get more and more output from a limited area of land? What have been the historical regional trends in the use of fertilizer, irrigation, and farm machinery? What criteria should we use in deciding whether to stress the shipment of food to needy countries or the wherewithal to produce additional food? And finally, what are the implications of this study for U.S. agriculture?

The Method

This is essentially an empirical-historical study, designed to add perspective to the problem of projecting the man-land-food relationship over the remaining decades of this century. Long-term historical trends are constructed for regional population; regional grain production, acreage and yields; total and net regional grain trade and regional agricultural inputs such as fertilizer, machinery, and irrigated area. Regional grain production, acreage, and yield trends are constructed so as to focus on the relative contributions to additional output of expanding acreage and rising yields. This gives an indication of the future relative importance of land inputs versus capital inputs by region.

Three simple techniques have been particularly useful throughout this study; collectively they have greatly simplified the task of analysis. These three techniques are the use of selected multi-year averages, heavy reliance on regional data as opposed to individual country data, and the use of all grains considered aggregately as an indicator of overall agricultural trends.

Multi-year averages, selected at the outset were designed to provide coverage of the past quarter century. These multi-year

averages reduce variations due to short-term weather and price fluctuations and thus serve to isolate the basic long-term trends. By using the same time periods for production and trade, it becomes a relatively simple matter to combine per capita net trade with per capita production to get per capita availability.

Four time periods are used: 1934-38, 1948-52, 1957-59, and 1960. The first time period, the immediate prewar years, is the earliest period for which adequate data are available. The 1948-52 period is likewise the first postwar period for which complete data are conveniently available. The 1957-59 period represents a relatively recent period. The single year, 1960, is selected because it is the most recent year--the most recent point on the long-term trend--for which data are available for all regions.

Three different world regional breakdowns are used consistently throughout this study for all general areas of discussion. The three regions are delineated on the basis of geographic, economic, and political characteristics. The first breakdown is the most detailed. It views the world as seven independent geographic regions. These are North America, Latin America, Western Europe, Eastern Europe together with the USSR, Africa, Asia, and Oceania. North America and Latin America are separated by the Rio Grande River; Western Europe includes Scandinavia, the United Kingdom, and Ireland as well as the Continental countries; Eastern Europe and the USSR corresponds with the Soviet Bloc; Africa includes the entire continent; Asia begins with Turkey and continues east to Japan and south to Indonesia including all communist Asia; and Oceania is essentially Australia and New Zealand.

The regional breakdown on an economic basis yields two regions--the developed and less developed. This breakdown focuses attention on the flow of resources from rich to poor. The developed regions consist of North America, Western Europe, Eastern Europe and the USSR, and Oceania; the less developed regions consist of Asia, Africa, and Latin America. The more developed countries in the less developed regions are separated out in many studies but in the context of this study it seemed best to simplify the analysis and keep the less developed geographic regions intact.

Delineation of the world on a political basis yields two regions--the Communist Bloc and the Free World. This approach is designed to provide perspective on agricultural progress in the Free World and the Communist Bloc by inventorying the past performance of agriculture under the contrasting free enterprise and collective or communal systems. The Communist Bloc consists of Eastern Europe and the Soviet Union plus Communist Asia. All other regions make up the Free World. No effort is made to analyze the differences between the two political regions; they are treated only in summary fashion.

The third tool, the use of all grains considered aggregately as an indicator for agriculture in general, greatly simplifies the analysis. Grains account for 71 percent of the world's harvested crop area; they provide 53 percent of man's supply of food energy when consumed directly and a large part of the remainder when consumed indirectly in the form of livestock products. When measured in terms of calories, grains completely dominate world trade in foodstuffs.

Grains are sufficiently similar that they can be aggregated on a weight basis, whereas if all agricultural output were used as the indicator this would not be possible. Grain data, too, are more consistent and complete than are data on all commodities. Trends in production, cultivated area, and yields are relatively easy to compile or compute because they are conceptually quite simple. To calculate yield trends, for instance, for all crops considered aggregately would be quite complicated by comparison.

Underlying this entire analysis has been the need for realistically assessing future resource requirements. Once trends in regional population growth, regional trends in grain production, acreage and yields, and net regional trends in grain trade are constructed, they may be projected under various combinations of assumptions.

The purpose of the arbitrarily selected projection models is not necessarily to show what will happen but what, in fact, would happen if certain assumedly modest consumption levels are to be met. Estimates of future production requirements in the less developed regions are then used to compute the amount of fertilizer needed. Fertilizer is singled out in this exercise because it will undoubtedly dominate capital inputs. Because of this, estimated requirements provide a good indication of the magnitude of future capital inputs.

Chapter II.--POPULATION

To simplify discussion, projected population figures are accepted as fact and not explicitly identified as projected figures. These projected figures are the medium estimates of the United Nations published in 1958 (57).[1] It might be noted here that data available since publication indicate that the medium range projections are almost universally underestimated in less developed countries. Underestimation does not, however, seem sufficient to warrant the use of the high range of population figures.

Historical Trends in World Population Growth

World population, at any given point in time, is equal to the total number of births minus the total number of deaths occurring since man's beginning. Throughout most of man's often precarious existence the number of births has not significantly exceeded the number of deaths. Over the last few centuries, more particularly the last few decades, man has drastically altered the balance between births and deaths. The old equilibrium has been destroyed but a new equilibrium has not yet developed. That the current disequilibrium cannot continue indefinitely is certain (fig. 1). Until a new balance is created, however, man must seek to accelerate the supply of food to match the increase in numbers.

At the time of Christ, world population was estimated to have numbered about 250 million. This number slowly expanded and by 1600, it had doubled, reaching 500 million. During this 16-century interval the rate of increase ranged between 2.5 and 5 percent per century. (37) By 1900 the annual rate of increase was nearly 1 percent. As of 1960 it was about 2 percent, and expected to be well above this figure for the remainder of this century. Population increase rates of 2 to 3 percent annually are so recent a phenomenon that man has scarcely begun to assess their long-term impact. A population growing 3 percent annually will multiply 18 fold in a century.

[1] Underscored numbers in parentheses refer to items in Bibliography, p.

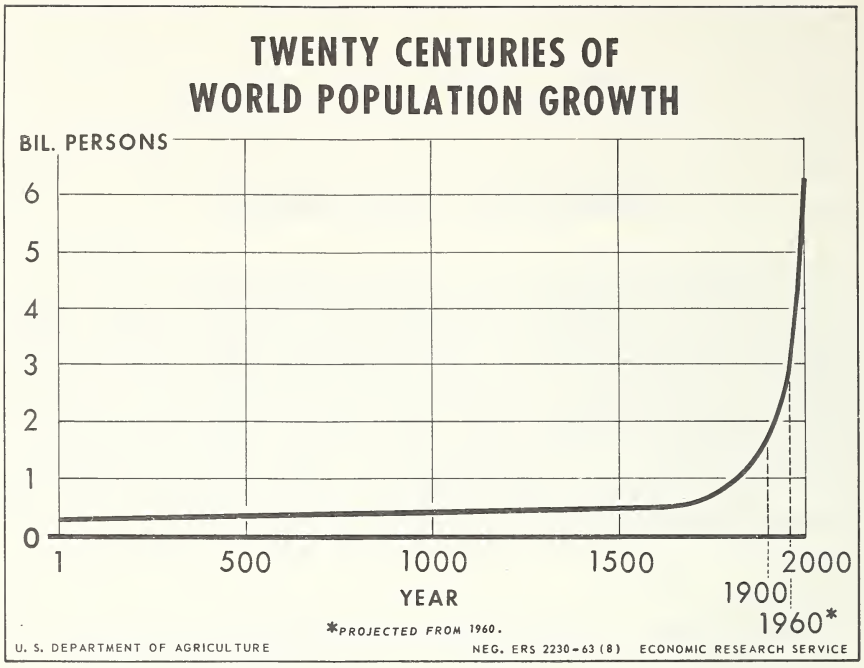

Figure 1

From the beginning of the human race until 1960, man gradually developed the food production capacity required to sustain 3 billion people, although the available per capita food supply for many is still quite meager. If the 6 billion plus of the year 2000 are to be sustained, man will need to develop the capacity to feed another 3 billion, but in only 40 years. The startling aspect of the population projected for the end of the century then is not so much the actual numbers but the rapidity with which the increase will occur.

Distribution of Population by Geographic Region

Population is distributed very unevenly throughout the world (tables 1 and 2). The greatest concentrations are in Asia. North America and Oceania encompass a land area of 6.9 billion acres compared with Asia's 6.7 billion, a cultivated land area of 635 million acres compared with 1,100 million acres but a population of only 213 million compared with 1,620 million.

India, covering an area one-third of that of the United States, now contains 450 million people, more than the entire Western

Table 1.--Regional and world population: Actual 1900-1960 and projected 1960-2000

Region	1900	1910[1]	1920[2]	1930[2]	1940[2]	1950	1960	1970	1980	1990	2000
	-Millions-										
North America.....	81	99	117	135	146	168	197	225	254	283	312
Latin America.....	63	76	90	109	131	163	206	265	348	455	592
Western Europe[3]....	205	220	236	258	279	278	300	321	352	388	421
E. Europe & USSR[3]..	219	234	250	273	297	296	339	390	440	483	526
Africa.....	120	130	140	155	172	199	235	278	333	410	517
Asia.....	857	914	970	1,047	1,176	1,380	1,620	1,980	2,470	3,090	3,870
Oceania.....	6	7	9	10	11	13	16	19	22	26	29
Total.....	1,551	1,680	1,812	1,987	2,212	2,497	2,913	3,478	4,219	5,235	6,267

[1] Figures for this year were not included in the original source but were arrived at by interpolation.
[2] Figures for these years were taken from D. Groenveld, Investment for Food, 1961, p. 107.
[3] For some years figures were available only for "Europe" as a whole in which case the breakdowns between Eastern and Western Europe are estimates based on years for which separate data are available.

Source: United Nations The Future Growth of World Population, 1958 (57).

Table 2.--Regional shares of world population: Actual 1900-1960 and projected 1960-2000

Region	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
	-Percent-										
North America.....	5.2	5.9	6.5	6.8	6.6	6.7	6.8	6.5	6.0	5.5	5.0
Latin America.....	4.1	4.5	5.0	5.5	5.9	6.5	7.1	7.6	8.3	8.9	9.4
Western Europe.....	13.2	13.1	13.0	13.0	12.6	11.1	10.3	9.2	8.3	7.5	6.7
E. Europe & USSR...	14.1	13.9	13.8	13.7	13.4	11.9	11.6	11.2	10.4	9.4	8.4
Africa.....	7.7	7.8	7.7	7.8	7.8	8.0	8.1	8.0	7.9	8.0	8.2
Asia.....	55.3	54.4	53.5	52.7	53.2	55.3	55.6	56.9	58.6	60.2	61.8
Oceania.....	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.5	0.5
Total.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: See table 1.

Hemisphere. Japan, though smaller than California, contains a population half that of the United States. Australia, easily twice the size of India, has only 11 million people. According to 1960 population statistics, 1,620 million or well over half the world's people were located in Asia, one of seven major geographic regions. This unequal distribution of population is not in itself necessarily a problem but, since man still must depend upon the land for his supply of food, the extent to which the population distribution pattern varies from that of cultivable land and the other non-human, complementary input, capital, certain problems arise. These pronounced variations in the distribution of population, cultivated land, and capital are the source of many current problems. The problem is not necessarily that world agricultural production potential is not capable of meeting immediate world needs but that areas of production potential and of deepest need are widely separated.

Differences between populations and cultivable land distribution patterns can be offset if capital is readily available in land-short areas. Capital may be either substituted for land in the production mix or used to purchase needed food from other areas. If income

levels and foreign exchange earnings are such as to permit the necessary purchases of food, then the problem is essentially a logistical one. Western Europe is perhaps the best example.

If capital is not readily available in land-short areas, indigenous needs can be met neither through capital substitution for land in the production mix nor through food purchases from other areas. Situations of this sort, now emerging rapidly in Asia, give rise to serious social, economic, and political problems. Unless some means of alleviating this situation can be found soon, the problem may acquire a critical dimension without precedent.

Regional Population Growth Rates

One of the unique features of the current era in human history is that population is growing everywhere (fig. 2). In times past,

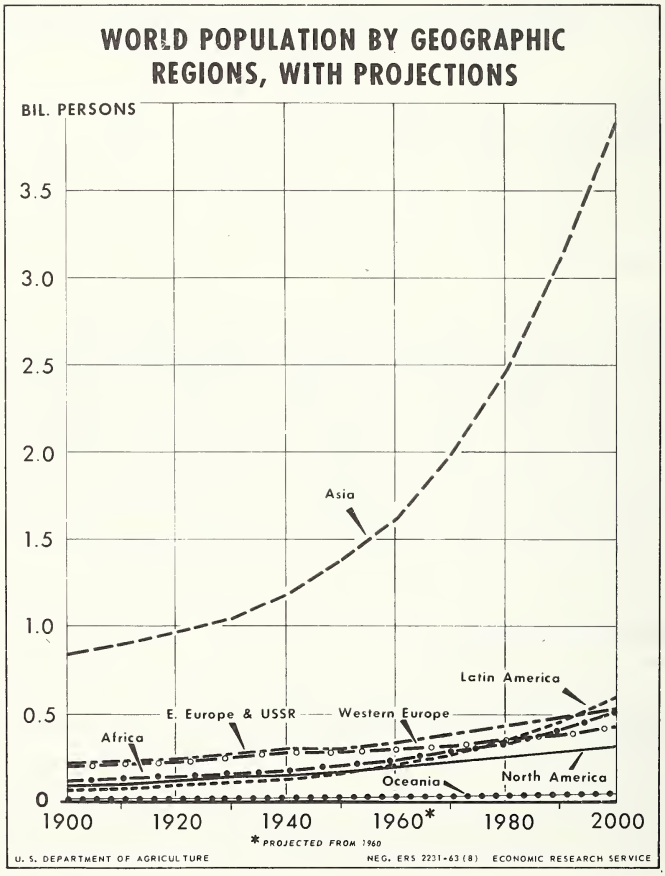

Figure 2

regional populations have remained constant for extended periods of time, for centuries in many instances. The first 60 years of this century have witnessed growth in every major geographic region in every decade with the exception of the war decade of the forties when both Western Europe and the Soviet Bloc suffered net losses in population (table 3). Barring nuclear war, widespread starvation, or other major disaster, substantial growth in every region for each decade appears to be the rule for the remainder of this century.

Population growth rates vary widely among regions. The extent to which they vary and the implications of these variations are not well known. A growth rate of 10 percent per decade produces less than a three-fold increase over the course of a century; a 20-percent rate yields a six-fold increase and a 30-percent rate results in an almost inconceivable increase of 14 fold.

In terms of actual rates of growth, Latin America has had a consistently higher rate than any other geographic region thus far this century. The total population of Latin America has increased more than three fold thus far and present projections indicate a total increase of 9 fold during this century (fig. 3).

During the four decades remaining between now and the year 2000, Latin America is expected to add nearly 400 million people to its current population of just over 200 million. North America, meanwhile will be adding just over 100 million to its population of under 200 million. The Northern and Latin portions of the Western Hemisphere had populations of comparable size through the first five decades of the 20th century but at mid-century the two regions diverged with North America following a medium growth path and Latin America a high growth path. Thus, if these projections hold, population in the southern part of the Western Hemisphere will be nearly twice that of the northern part by the year 2000, only 37 years hence. That Latin America has experienced considerable difficulty

Table 3.--Decade rates of regional population growth: Actual 1900-1960 and projected 1960-2000

Region	1900-1910	1910-1920	1920-1930	1930-1940	1940-1950	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000
	Percent									
North America.....	22.2	18.2	15.4	8.1	15.1	17.3	14.2	12.9	11.4	10.2
Latin America.....	20.6	18.4	21.1	20.2	24.4	26.4	28.6	31.3	30.7	30.1
Western Europe.....	7.3	7.3	9.3	8.1	-.4	7.9	7.0	9.7	10.2	8.5
E. Europe & USSR...	6.8	6.8	9.2	8.8	-.3	14.5	15.0	12.8	9.8	8.9
Africa.....	8.3	7.7	10.7	11.0	15.7	18.1	18.3	19.8	23.1	26.1
Asia.....	6.7	6.1	7.9	12.3	17.3	17.4	22.2	24.7	25.1	25.2
Oceania.....	16.7	28.6	11.1	10.0	18.2	23.1	18.8	15.8	18.2	11.5
World	8.4	8.0	9.4	11.3	12.9	16.8	19.4	21.3	21.7	22.0

Source: See table 1.

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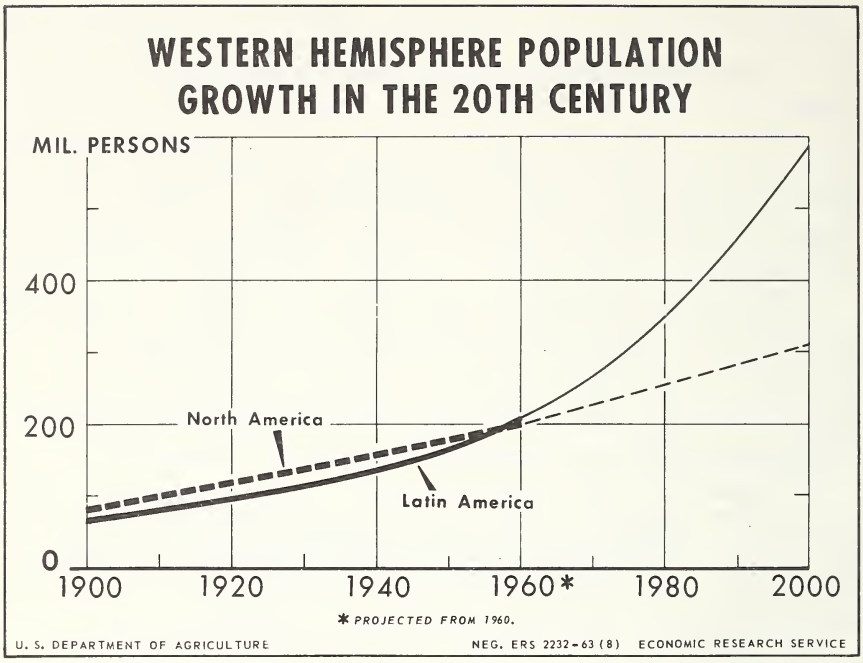

Figure 3

in attempting to feed, clothe, and educate its people thus far is obvious. What can be done to meet these basic needs as Latin America adds 400 million to its present numbers during the brief span of the next four decades remains to be seen.

Population growth in Asia, although somewhat less rapid than in Latin America, assumes a critical dimension, for this region is already densely populated and a serious imbalance exists between population and food producing capability. Asia made the transition from surplus to deficit with respect to grains during the 40's and 50's when population was growing at only 17 percent per decade. What will happen during the remainder of this century when the decade rate will range from 22 to 25 percent is not possible to predict.

Asia, heavily dependent on extra-regional sources of food, currently has a population of 1.6 billion. This is expected to increase to 3.1 billion the current world population, by 1990. Should this projection materialize, Asia will have to develop a surplus above present grain output sufficient to supply a number equivalent to the entire current population of the other six geographic regions. To achieve a feat of this magnitude with handicaps imposed by dwindling per capita land availabilities and a paucity of agricultural capital is almost inconceivable.

Differential rates of population growth between geographic regions result in shifts in world population distribution (fig. 4). Latin America, with its exceptionally high birth rate and continued immigration, is expected to expand its share of world population from 4.1 to 9.4 percent during this century. Asia and Africa are expected to show a moderate gain in percentage share of total population. The developed regions of recent settlement, Oceania and

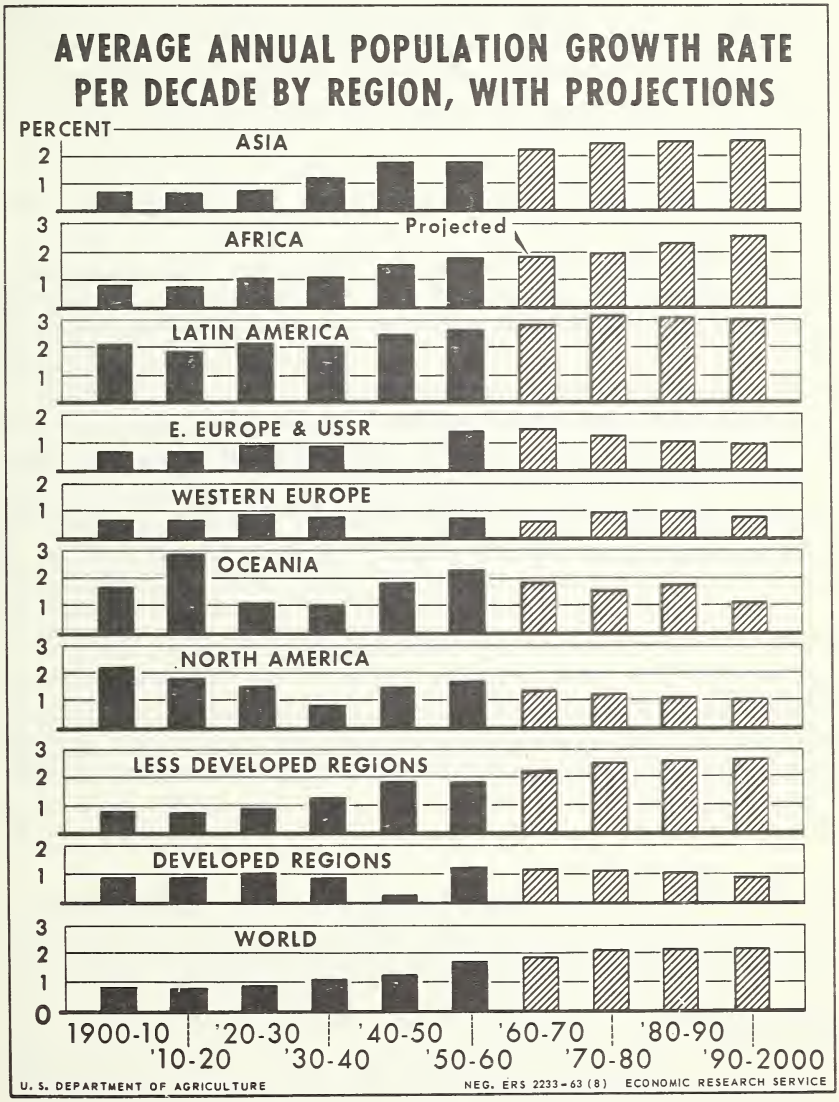

Figure 4

North America, are expected to grow at about the same rate as the world, thus maintaining rather constant shares. The Old World portion of the developed region, Europe and the Soviet Union, is expected to continue its dramatic relative decline going from one-fourth of world population in 1900 to one-seventh in 2000.

Migration has influenced growth rates in the past but its future influence is likely to be confined largely to Oceania and, to a lesser extent, to Latin America and North America. The young people emigrating from Europe have undoubtedly reduced growth rates there especially during the earlier part of this century. The same young people emigrating into North America and Oceania have supplemented the indigenous rates of natural increase.

Population in the Two Economic Regions

At the beginning of this century, the three regions designated as less developed--Asia, Africa, and Latin America--contained 1,040 million people or 67 percent of world population (tables 4 and 5). By the end of this century the share is expected to increase to 79 percent or 5 billion of a 6.3 billion world total. The share of population in the rest of the world--that labeled as developed--must concommitantly decline, dropping from roughly one-third to one-fifth.

Total population growth in the regions currently classed as less developed is expected to amount to almost 4 billion people during

Table 4.--Population by economic regions: Actual 1900-1960 and projected 1960-2000

Region	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
	Millions										
Developed regions	511	560	612	676	733	755	852	955	1,068	1,180	1,288
Less developed regions[1]	1,040	1,120	1,200	1,311	1,479	1,742	2,061	2,523	3,151	3,955	4,979
World	1,551	1,680	1,812	1,987	2,212	2,497	2,913	3,478	4,219	5,135	6,267

[1] Asia, Africa, and Latin America.

Source: See table 1.

Table 5.--Population distribution by economic regions: Actual 1900-1960 and projected 1960-2000

Region	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000
	Percent										
Developed regions	32.9	33.3	33.8	34.0	33.1	30.2	29.2	27.5	25.2	22.9	20.6
Less developed regions[1]	67.1	66.7	66.2	66.0	66.9	69.8	70.8	72.5	74.8	77.1	79.4
World	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Asia, Africa, and Latin America.

Source: See table 1.

this century. This compares with a total addition of less than 800 million in the developed regions. In terms of relative increase, population is expected to multiply 5 fold in the former but only 2-3 fold in the latter. As of 1960, only 1 billion of the 4 billion total in the less developed region had been added thus reserving the impact of this phenomenal growth in numbers for the closing decades of this century.

Population has not always grown faster in the less developed regions; in fact, during the first three decades of this century, the reverse was true. Disease control was first effectively applied in the developed world, the region associated with the industrial revolution. It was here that population emerged from the near static state prevailing throughout most of man's history and entered into a period of sustained growth. In the less developed regions, the reduction of death rates progressed rapidly during the fourth, fifth, and sixth decades and it was not until this occurred that growth rates exceeded those in the developed regions (fig. 4). This was also facilitated by the fact that the rate of growth in the developed regions was apparently leveling off, reaching its peak in the 50's and then gradually trending downward.

If the abnormal effects of widespread depression in the thirties and war in the forties are ignored, a clear trend emerges in the developed world of gradually rising rates until the mid-century peak in the fifties after which the growth rate gradually tapers off until the end of the century. The trend is quite different, however, in the less developed regions. Here, except for the second decade, the growth rate goes higher each successive decade from 1900 to 2000.

Of great significance is the difference in peak population growth rates between the two economic regions. The developed region, assumedly reaching its peak in this century, never went above 13 percent per decade, whereas growth rates in the less developed regions reached this level in the thirties, are well above 22 percent now, and expected to reach 26 percent by the last decade of the century (table 6).

Table 6.--Decade rates of population growth by economic regions: Actual 1900-1960 and projected, 1960-2000

Region	1900-1910	1910-1920	1920-1930	1930-1940	1940-1950	1950-1960	1960-1970	1970-1980	1980-1990	1990-2000
	Percent									
Developed regions..	9.6	9.3	10.5	8.4	3.0	12.8	12.1	11.8	10.5	9.2
Less developed regions[1].....	7.7	7.1	9.2	12.8	17.8	18.3	22.4	24.9	25.5	25.9

[1] Asia, Africa, and Latin America.

Source: See table 1.

The developed regions have made most progress during a period when population was growing at less than 10 percent per decade or well under 1 percent per year. If the less developed regions are to make comparable progress, they must do it under the double burden of a much higher population growth rate and a much smaller per capita endowment of natural resources.

Population--Principal Countries

Although the world is now composed of well over 100 countries, a very small handful contain most of the world's people. China, the largest, currently encompasses within its boundaries over one-fifth of the human race. India, second in size, represents one-seventh of all mankind. These two plus the third and fourth ranking nations, the Soviet Union and the United States, contain over one-half of the world's current population of just over 3 billion. These four now contain almost as many people as were in the world in 1900. After the United States come Japan, Pakistan and Indonesia, with 93 million people each. All of the seven most populous countries, except the United States and the Soviet Union, are in Asia.

Brazil, the eighth ranking country, is the largest country in Latin America but it is nonetheless quite small compared with the leading countries of Asia. The next four countries, West Germany, the United Kingdom, Italy, and France, are all in Western Europe.

India's population, according to official government planners, as quoted by Jones, is expected to grow at an annual rate well in excess of 2 percent annually (37, p. 15). From the beginning of the Third 5-Year Plan in 1961 until the end of the Fifth 5-Year Plan in 1976, the increase is expected to amount to 187 million. This means that food output must expand enough to feed an additional population complement equal in size to the current population of the United States. Paralleling this is a planned expansion in the net area sown of only 6 million acres or a total of 2 percent during the same period (30, p. 102).

China's population, too, is estimated to be increasing 2 or more percent annually. At this rate, annual additions amount to 12-15 million or approximately the equivalent of Australia's population. Finding, each year, enough food for a population increment of this size presents a staggering challenge.

Of all the countries faced with a critical population problem, only one, Japan, has reacted positively. During the immediate postwar years, Japan's population, already pressing hard on the

island's limited resources, was expanding at a rate of 2 to 3 percent annually. It soon became evident that Japan's long term economic growth was imperiled by uncontrolled population growth.

The Japanese reacted quickly, initiating a program of education and assistance in family planning. Both the government and private groups cooperated in achieving a resounding success. By the late 1950's the annual population increase had dropped below 1 percent per year. This achievement has undoubtedly been an important factor underlying Japan's unprecedented rate of per capita economic growth.

Chapter III.--LAND

Certain facts associated with land deserve to be recognized. First, it is the source of man's food supply. Second, land is in limited supply. Man has always been dependent upon the land for food, even during the prehistoric hunting and gathering stage. As man learned to plant seeds and till the soil the capacity of the land to sustain human life was increased many times over. With the application of modern science to agriculture, the population sustaining capacity of the earth was still further enhanced.

Man has also traditionally depended upon the sea for some of his food, namely fish and other forms of marine life. But this source of food is quite minor, accounting for less than 1 percent of the total food energy supply.

Other methods of producing food bypass, at least partially, the use of land in the food producing process. Hydroponics, or plant culture without soil, has been technically possible for a long time but it is too costly to be economically practical on a large scale. Besides, most of the nutrients used to feed plants so raised must be extracted from the soil. A few are available in the atmosphere and the ocean.

Synthetic fabrication of many basic foods is possible but usually too costly to consider on a large scale. And again, most of the raw materials used in the synthesis are of agricultural origin.

In spite of the vast scientific store of knowledge, no practical substitute for land in the food producing process is known. Nor does it seem likely there will be any in the foreseeable future. This study assumes that conventional agriculture will continue to supply a share of man's food supply in the future not too different from that in the past.

Most of man's successful efforts in expanding food output have been in the area of improving existing land. Large areas of land, for example, have been well suited for cultivation except for an inadequate water supply. This has been remedied by irrigation. Other areas have required drainage. Thus far efforts have been concentrated in correcting minor defects to render the existing land supply productive. Some land has such serious defects as to make efforts to make it productive too costly to consider. Much of the earth's land surface falls into this category. It is too cold, too steep, lacking in the basic nutrients, or too dry and too far from an adequate water source to permit irrigation.

As capital becomes more plentiful, as cheaper sources of energy are developed, and as more efficient means of converting sea water to fresh water become available, considerable land may be added to that currently under cultivation. At this time, it seems that little additional land, by nature well suited for cultivation, is available. Any substantial additions to the currently cultivated area must await the investment of human effort and capital, in irrigation, drainage, or other land improvement.

The World's Agricultural Land Resources

A certain ambiguity attaches to the terms "agricultural," "arable," and "cultivable" land that makes aggregation and the construction of historical trends difficult. Conceptual difficulties, however, are only the beginning, because once the terminology, e.g., arable land, is decided upon, varied interpretations in individual countries, with varying types of agriculture, further compound the difficulties.

The world's land surface is currently estimated at 32.9 billion acres (table 7). Of this, 3.5 billion acres or just under 11 percent of the total is classified as arable land and land in tree crops. The amount actually planted to crops in a given year is considerably less, usually under 2.4 billion acres. This amounts to only 7.6 percent of

Table 7.--Land utilization pattern, by regions, 1959

Region	Arable land and land under tree crops	Permanent meadows and pastures	All other land	Total area[1]
	Million acres			
Geographic regions				
North America	566	688	3,524	4,778
Latin America	252	913	3,902	5,067
Western Europe	242	140	522	904
E. Europe & USSR	686	967	4,198	5,851
Africa	583	1,463	5,429	7,475
Asia	1,073	1,077	4,559	6,709
Oceania	69	1,104	937	2,110
World[2]	3,471	6,352	23,071	32,894
Economic regions				
Developed regions	1,563	2,899	9,181	13,643
Less developed regions	1,908	3,453	13,890	19,251
Political regions				
Free World	2,515	4,946	17,170	24,631
Communist Bloc	956	1,406	5,901	8,263

[1] Refers to total area of the country including area under inland water bodies.
[2] Excludes Greenland and Antarctica.

Source: FAO Production Yearbook, 1960 (15).

the earth's land surface. By definition, the difference between arable land and area actually planted is fallow land and land in temporary pastures.

The combined area classified as permanent meadows and pastures amounts to 6.4 billion acres or 19 percent of the earth's land surface. Agricultural land, if considered to include arable land and permanent pasture, then accounts for 30 percent of the earth's land surface.

The 70 percent of the earth's surface not classified as agricultural land may not be well suited to agriculture for many reasons. Much of the world is too dry to support much plant life. A large part of the African continent is covered by the Sahara desert. The Thar desert, covering the northwestern corner of the Indian subcontinent, is larger than the combined cultivated area of East and West Pakistan. Much of East Asia (Mongolia and North China) are covered by the vast Gobi desert. Australia is largely desert and wasteland. Deserts are somewhat less common, however, in the Western Hemisphere and Europe.

If rainfall is not a limiting factor, land may be too cold or at an elevation too high to support commercial crops. Regions too cold or high are represented by the northern latitudes of Canada and the Soviet Union, the Rocky Mountains, the Andes, the Alps, and the vast Himalayan Plateau.

Geographic distribution

The distribution of arable land is very uneven throughout the world (table 8). A few regions are favored with large concentrations of fertile agricultural land (fig. 5). Continental Western Europe, continental United States east of the Rocky Mountains and India comprise the principal world concentrations of fertile agricultural land. For selected states in the United States and India or individual countries of Western Europe, the share of land under cultivation often exceeds one-half.

Some of the world's major geographic regions have very low percentages of arable land. Notable among these is Latin America with only 5.0 percent of its area listed as arable. Australia and Canada, both leading surplus food producers, cultivate only 3-4 percent of their total area.

The share of land suitable for cultivation varies greatly between countries even within a geographic region. Forty-nine percent of the land in India is arable but in China only 11 percent is. Within Western Europe, about 65 percent of Denmark is arable but only 2 to 3 percent of Norway can be cultivated. Among Latin

Table 8.--Percentage distribution of agricultural and total land by regions, 1959

Region	Arable land and land under tree crops	Permanent meadows and pastures	Total land area
	Percent	Percent	Percent
Geographic regions			
North America.....	16.3	10.8	14.5
Latin America.....	7.2	14.4	15.4
Western Europe.....	7.0	2.2	2.8
E. Europe & USSR....	19.8	15.2	17.8
Africa.....	16.8	23.0	22.7
Asia.....	30.9	17.0	20.4
Oceania.....	2.0	17.4	6.4
World.....	100.0	100.0	100.0
Economic regions			
Developed regions...	45.0	45.6	41.5
Less developed regions.....	55.0	54.4	58.5
Political regions			
Free World.....	72.5	77.9	74.9
Communist Bloc.....	27.5	22.1	25.1

Source: FAO Production Yearbook, 1960 (15).

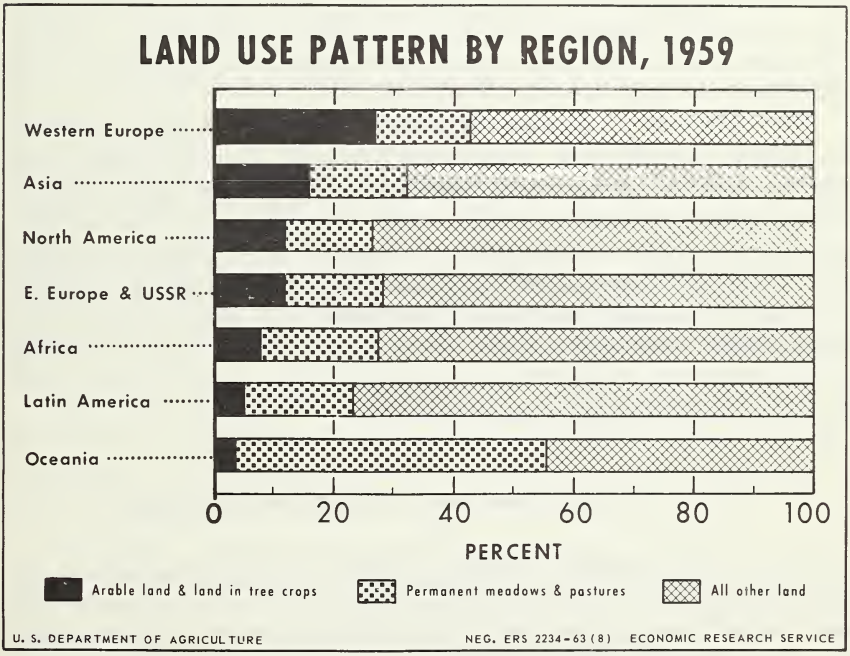

Figure 5

American countries, only 2 percent of Brazil is cultivated compared with 17 percent in Cuba.

Population and arable land are not at all evenly distributed. Asia, for example, currently contains 56 percent of the world's people but only 31 percent of the arable land. Western Europe, too, has a larger share of world population than arable land. All other regions have smaller shares of population than arable land. Oceania's arable land share of 2 percent is 4 times as large as its share of world population. Among the seven geographic regions, only Latin America has virtually identical shares of both world population and arable land.

Variations in Quality

Quality is a nebulous term when applied to land. Specific statements can be made only with reference to a particular crop or closely related group of crops. A region of heavy rainfall, annually inundated for several months each year, might be ideal for rice but it would never produce tea.

Quality of land, then, for a particular crop may vary with an almost infinite number of factors, which interact to produce a favorable environment. Principal among the factors determining the productive capacity of land, are rainfall, temperature, latitude, drainage, soil structure, acidity and mineral composition of the soil.

The inherent productive capacity of land can be greatly altered by careful management. Japan, for example, extracts some of the world's highest yields from land that is either inherently infertile or, at best, not notably fertile. This exemplary feat has involved painstaking effort in the form of drainage and irrigation projects and the use of large quantities of both traditional organic fertilizer and, more recently, chemical fertilizers. Japanese farmers have applied good management and large quantities of capital to attain yield levels two to four times as high as farmers elsewhere with land of comparable inherent fertility.

The Current Pattern of Land Utilization

Most of the world's cropland is devoted to the production of a relatively small number of crops (fig. 6). Grains alone accounted for 71 percent of the total harvested area in 1959; oilseeds, the next most important group of commodities, accounted for 7 percent; roots and tubers, pulses, and fibers accounted for

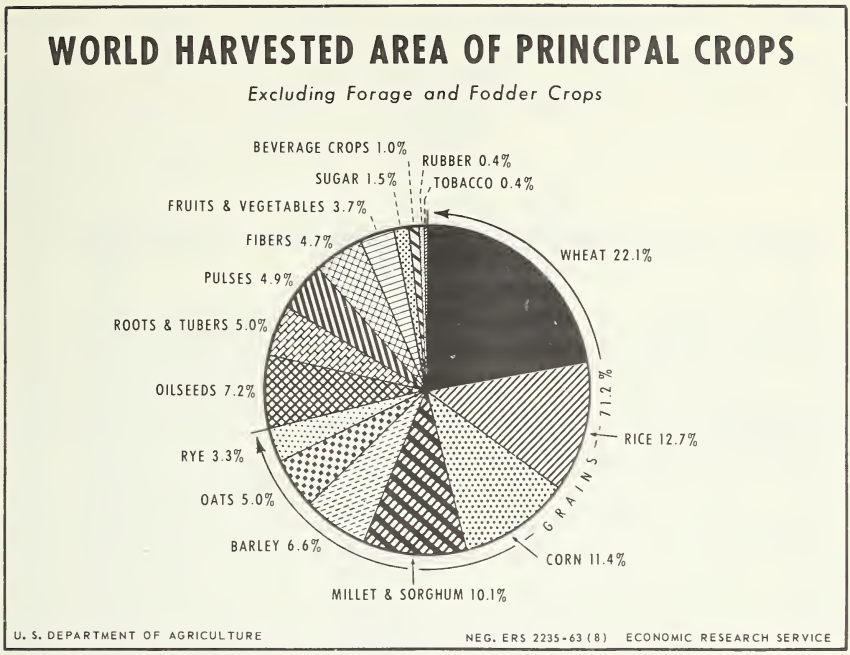

Figure 6

about 5 percent each.[2] The commodity groups thus far mentioned account for 93 percent of the total (table 9).

A breakdown of the harvested area according to edible and inedible crops shows some 94 percent being used to produce edible crops. Fibers account for most of the area devoted to inedible crops, the area in tobacco and rubber being rather small in the overall cropland utilization pattern. If it were possible to develop synthetic substitutes to replace rubber and the fibers entirely, the additional land area released for food production would not be large.

The share of cropland used to produce crops directly consumed by humans is far smaller than that producing edible crops. Although all grains are edible, possibly one-third of the area planted to grains is used to provide feed for livestock. Wheat and rice are

[2] Worldwide statistics on the area of all crops are not available. In table 9, and generally in this section "harvested area" refers to the major crops listed. Fallow land and omitted crops, such as hay, fodder crops, fruits, vegetables, and several oilseeds, account for most of the difference between "harvested area" and arable land as shown in table 7. The remainder is due to the deficiencies in the statistics.

Table 9.--World harvested area of principal crops, 1959/60

Crop	Area	Share of total cultivated area	Crop	Area	Share of total cultivated area
	1,000 acres	Percent		1,000 acres	Percent
Grains	1,628,464	71.2	Oilseeds	164,221	7.2
Wheat	505,814	22.1	Soybeans	52,138	2.3
Rice	290,095	12.7	Peanuts	36,324	1.6
Corn	261,185	11.4	Rapeseed	19,768	0.9
Millet & sorghum	231,286	10.1	Sunflowers	16,902	0.7
Barley	149,990	6.6	Sesame seed	11,861	0.5
Oats	113,666	5.0	Copra	11,609	0.5
Rye	76,428	3.3	Castor beans	[3] 3,112	0.1
			Palm kernels	[4] 12,507	0.6
Roots and tubers	114,654	5.0	Beverage crops	23,260	1.0
Potatoes	61,281	2.7	Coffee[5]	16,551	0.7
Sweetpotatoes & yams	35,582	1.5	Cocoa[5]	4,285	0.2
Cassava	17,791	0.8	Tea	2,424	0.1
			Fibers	108,527	4.7
Sugar	34,232	1.5	Cotton	83,273	3.6
Sugarcane	[1] 18,047	0.8	Flax	18,532	0.8
Sugar beets	16,185	0.7	Jute	4,720	0.2
			Hemp	2,002	0.1
Pulses	110,948	4.9	Tobacco	8,574	0.4
			Rubber	[6] 9,754	0.4
Fruits & vegetables	[2] 84,463	3.7	Total[7]	2,287,097	100.0

[1] USDA Foreign Agricultural Circular FS 1-62 Feb. 1962.
[2] World estimate based on U.S. data.
[3] Estimate based on partial data in USDA Foreign Agricultural Circular FFD 1-62 March 1962.
[4] Estimate based on acreage data and principal producing countries.
[5] For major producing countries.
[6] U.S. Dept. of Agr. figures.
[7] This total refers to the area of the main crops only. The area is generally the harvested area and excludes the area not harvested because of crop failure or other reasons. The crops covered are the main ones, except for hay and other fodder crops, but the aggregate area of the minor crops may be substantial. Temporary pasture land is included in "arable" land in table 7 but not here.

Source: FAO Production Yearbook, 1960 (15).

consumed largely as food but much of the remaining grain output is consumed by livestock.

Over 1.6 billion acres, or 71 percent of the world total of 2.3 billion acres in Table 9 were occupied by grain in 1959/60. Wheat acreage alone accounted for more than one-fifth of the total crop area. In spite of the substantially greater area planted to wheat than to rice--506 million acres against 290 million--rice accounts for 21.2 percent of man's energy supply as compared with only 19.6 percent for wheat. The calorie yield per acre of rice is about 1.8 million or nearly double the .96 million from wheat.

Great disparities exist between the importance of commodities in the world agricultural trade and land utilization patterns. Grains, for example, occupy 71 percent of the harvested area but account for only 17 percent, by value, of world agricultural exports. At the

opposite extreme is rubber, a crop occupying less than one half of 1 percent of the harvested area but accounting for 7 percent of world agricultural exports. The beverage crops--coffee, tea and cocoa--which account for only 1 percent of the area, represent 12 percent of all agricultural exports.

Three Historical Stages in the Population-Land Relationship

The relationship between population and agricultural land within a given country can readily be separated into three successive stages as population grows. All countries may then be conveniently classified into one of these stages. In the first stage, agricultural land is plentiful, much good land awaits settlement, and farmers can expand the aggregate cultivated area through individual effort. Burma, Brazil, and Nigeria currently fall into this category.

In the second stage, land is brought under cultivation principally through large scale cooperative or government projects. These efforts may take the form of large scale irrigation or drainage projects; they may involve the clearing of land with heavy machinery; or they may consist simply of eradicating malaria from previously uninhabited areas. India now appears to be well into the second stage, for most of the land being added to the cultivated area is the result of government sponsored reclamation projects.

When the third stage is reached it is no longer economically possible to expand the cultivated area and the acreage under cultivation begins to decline. The construction of highways, airfields, factories and homes begins to encroach upon farmland.

Japan, one of the first countries to reach the third stage, has experienced a gradual decline in area under cultivation since about 1920 (fig. 7). During the last four decades the cultivated area has been reduced 13 percent. Costly government reclamation projects seeking to offset the loss of agricultural land to other uses have been only partially successful. Output was maintained by dramatically raising yields and the historical goal of near self-sufficiency in food was attained only at great cost. In recent years, rice prices have been supported at levels 2 to 4 times those of the world market.

Some countries in Western Europe, notably Norway and Sweden, have been losing agricultural land for a period comparable to that of Japan. France's total farm acreage appears to have been undergoing an irregular decline throughout much of this century (fig. 8). The harvested area in the United States has declined in recent years but this reflects production controls more than population pressure (fig. 9).

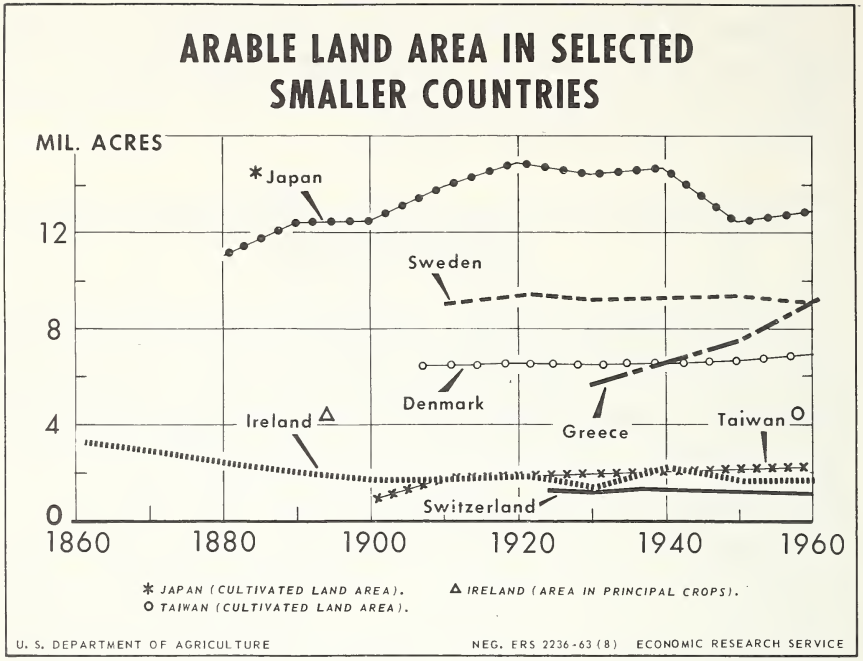

Figure 7

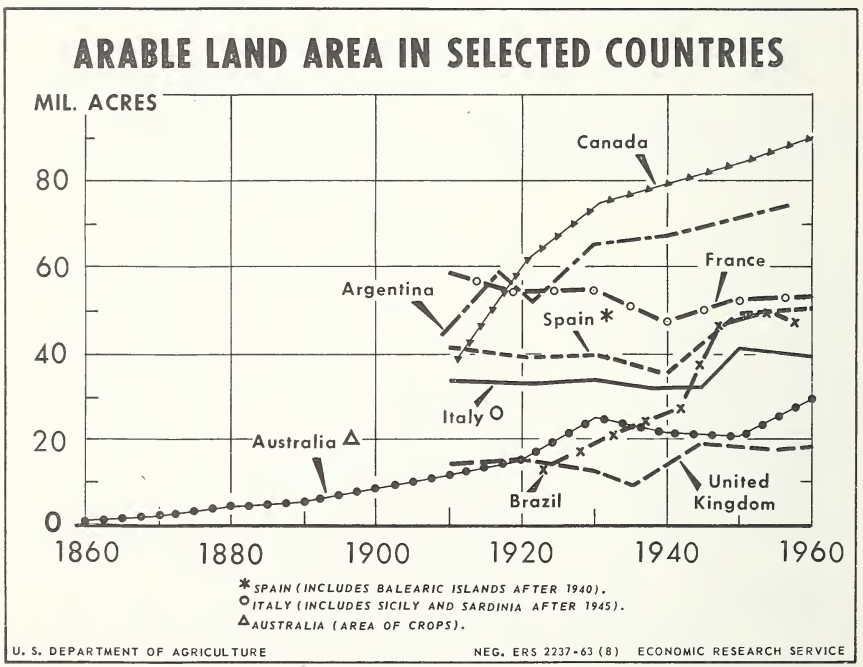

Figure 8

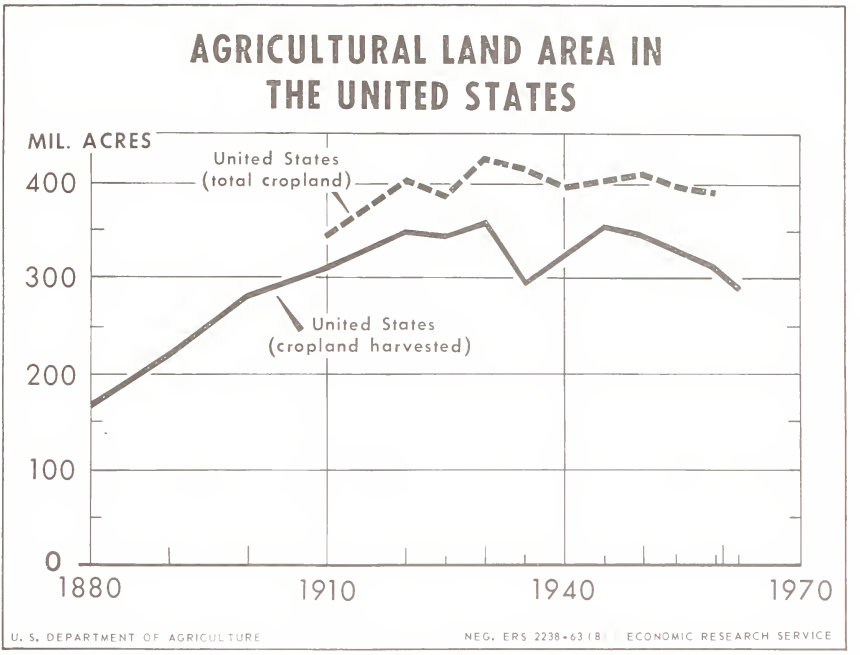

Figure 9

Following is an arbitrary classification of selected countries according to their position in the historical stages of the population-land relationship as outlined above:

Stage 1	Stage 2	Stage 3
Angola	China	Ireland
Brazil	Egypt	Japan
Burma	Greece	Sweden
Indonesia	India	Switzerland
Philippines	Soviet Union	United Kingdom
Thailand		

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Chapter IV.--FOOD

Composition of Diets

Regional Consumption Patterns

Consumption patterns of individual countries within a given geographic region or, more particularly, a geographic subregion, are often remarkably similar. Diets vary widely among geographic regions, however, especially between geographic regions classified as developed and those considered to be less developed. Differences in consumption patterns, then, seem to trace largely to variations in the prevailing climate and level of income.

The following paragraphs, from an earlier study by the author, discuss in summary fashion the determinants of consumption patterns and their relative importance:

> "Determinants of food consumption patterns are numerous and often inter-dependent. They may be divided into five categories: physical, economic, social, religious, and political. The physical and economic factors are usually the most important.
>
> "Physical factors such as location, weather, soils and length of growing season strongly influence the consumption pattern of a country or area through their effect on agricultural production. This influence is strongest in underdeveloped areas where transportation and distribution facilities are limited and where many of the people live at the subsistence level. Economic factors interact with the physical environment to play a leading role in shaping the consumption pattern. Unlike physical determinants economic factors are subject to considerable change; hence, any examination of shifts in food consumption patterns must center on the economic aspects of the consumption environment." (7, p. 1)

Regional consumption patterns are presented here in terms of the distribution of total calorie supply according to food group (table 10). The food groups used here are broad. Differences in calorie distribution between food groups seem to reflect variations in income rather than geographic variations, which are obscured by the broad grouping. The rice and wheat growing regions, for instance, cannot

Table 10.--Percentage distribution of total calorie supply by major food groups, by regions, 1958

Region	Grain products, roots, and tubers	Fruits, nuts, and vege-tables	Sugar	Fats and oils	Livestock products	Fish	Total
	-Percent-						
Geographic regions							
North America.....	24.4	9.1	15.8	19.9	30.6	.2	100.0
Oceania.....	30.0	5.6	16.3	12.3	35.2	.6	100.0
Western Europe.....	43.9	6.4	11.2	16.8	20.8	.9	100.0
Latin America.....	50.7	12.3	14.0	8.0	14.7	.3	100.0
E. Europe & USSR...	64.9	3.5	8.0	9.2	14.0	.4	100.0
Africa.....	70.1	11.5	4.1	7.5	6.3	.5	100.0
Asia.....	74.5	11.4	4.1	5.3	3.8	.9	100.0
World.....	62.7	9.6	7.3	8.9	10.8	.7	100.0
Economic regions							
Developed regions..	47.3	5.9	11.1	14.5	20.7	.5	100.0
Less developed regions.....	71.7	11.5	5.1	5.8	5.1	.8	100.0
Political regions							
Free World.....	58.8	11.4	8.7	9.3	11.0	.8	100.0
Communist Bloc.....	75.6	7.1	3.3	6.4	7.0	.6	100.0

Source: U.S. Dept. Agr. - Food Balances in Foreign Countries (19, 20, 21, 22).

be distinguished in the broad grouping because both wheat and rice are included in the category of grain products, roots and tubers. The next section of this study, which discusses food staples permits a closer examination of variations in diets due to geographic factors.

Variations in average diets of the seven major geographic regions is great. The share of total calorie intake derived from grain products, roots and tubers, varies from 24 percent in North America to 75 percent in Asia. Similar figures for livestock products range from 4 percent in Asia to 35 percent in Oceania.[3]

The two regions with the highest average per capita incomes, North America and Oceania, have remarkably similar consumption patterns (fig. 10). North America is slightly lower in consumption of grain products, roots and tubers and livestock products but higher in consumption of vegetable oils and fruits, nuts and vegetables.

If a low share of calories from starchy foods is assumed to indicate a high level of living and therefore a state of economic "development", Eastern Europe and the Soviet Union would, surprisingly, be considered less developed than Latin America. Latin America depends on grain products, roots and tubers, for only 51 percent of its food and energy requirements whereas Eastern Europe and the Soviet Union, depends on these starchy foods for 65 percent of the food energy supply. The other principal indicator of level of living, the share of livestock products in the diet,

[3] Calculations are based on data appearing in the food balances constructed in the Regional Analysis Division of the Economic Research Service.

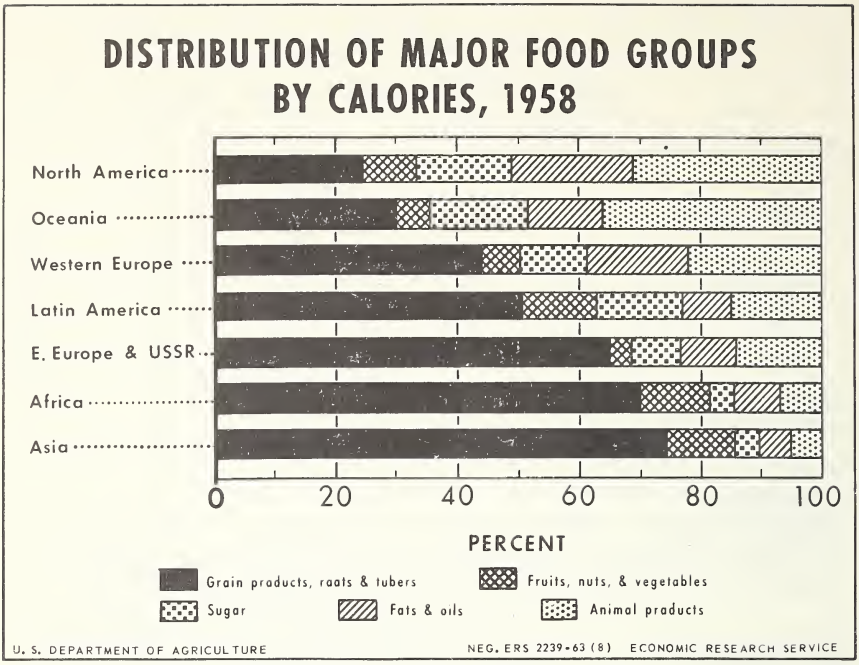

Figure 10

reinforces this conclusion for, here too, Latin America is in a slightly favored position. Africa and Asia have rather similar consumption patterns, the principal difference being that the share of calories derived from grain products, roots and tubers is higher in Asia, 75 percent against 70 percent. The share from livestock products is 6 percent in Africa as compared with 4 percent in Asia.

A division of the world into developed and less developed regions shows the share of calories from the starchy food group, fruits and vegetables, and fish as being higher in the less developed regions. The share from the three remaining groups--sugar, fats and oils, and livestock products--is higher in the developed world. Starchy foods provide 72 percent of all calories in the less developed regions but only 47 percent in the developed region. The share of calories derived from grain products, roots and tubers of diets in the developed regions would be much lower were it not for the Soviet Bloc with its disproportionately high consumption of grains and potatoes. Calories derived from the consumption of livestock products make up 21 percent of the total energy intake in the developed regions but only 5 percent in the less developed regions.

If the world is divided politically into two parts, the Free World and Sino-Soviet Bloc, diets are more favorable in the Free World but the difference between these political regions is much less than between the economic regions. The share of calories from grains is greater in the Sino-Soviet Bloc but the shares of all other groups are smaller thus indicating overdependence on starches as a source of food energy. The share of calories derived from grain products, roots and tubers in Communist China is higher than in any other major country.

National diets

Differences in the composition of diets of individual countries within a region are usually much less than between regions (table A-2). Within the two regions with the highest average per capita income, North America and Oceania, diets are strikingly similar.

North America consists of two countries, Canada and the United States, and Oceania two also, Australia, and New Zealand. These four countries are unique among nearly 90 countries on which data are available in that they are the only countries deriving more calories from livestock products than from starchy foods. The share of food energy supplied by starchy foods ranges from 24 percent in the United States to 31 percent in Australia; the livestock products share, from 30 percent in the United States to 40 percent in New Zealand. Average per capita incomes in these countries vary from $1,100 per year in Australia to $2,300 in the United States. In countries with incomes above $1,000, consumption patterns vary little between countries. Variations that do exist have relatively little nutritional significance.

Within some regions, considerable variation exists among geographic subregions. Western Europe is perhaps one of the best examples of this, possibly because of wider income variations between subregions. Consumption patterns, for example, vary widely between the Scandinavian countries (Denmark, Norway, Sweden, and Finland) and the Mediterranean countries (Spain, Portugal, Italy, and Greece). The Scandinavian group depends upon starchy foods for only 32-43 percent of its food energy supply as compared with 54-58 percent for the Mediterranean group. Comparable figures for livestock products, an item usually associated with higher income levels, vary from 25-29 percent in the former group to 7-12 percent in the latter.

Africa may be divided into two rather homogeneous subregions. One consists of the northern tier of countries and the other, the section lying south of the Sahara. The share of calories derived from

starches is about the same in both the northern and southern regions but the sources of starch are quite different. Grain products account for virtually all starchy food in the north but below the Sahara roots and tubers account for nearly half of the calories from starches. In some countries of West Africa such as Nigeria and Ghana, roots and tubers such as cassava, sweetpotatoes, yams and cocoa-yams supply the greater part of starch consumed.

The composition of diets according to major food groups probably varies more between countries within Latin America than in any of the other geographic regions. The share of calories coming from grain products, roots and tubers is not over 60 percent in any of the countries except Honduras but in several countries, bananas and plantains, foods that are essentially starchy foods, are included under fruit. Thus, the share of calories derived from starchy foods is in fact higher than it first appears. Uruguay, one of the better fed countries in the region, has a consumption pattern comparing rather favorably with those of North America and Oceania. The share of calories derived from livestock products is in fact higher than in the United States though lower than Canada. Argentina, too, enjoys a rather favorable distribution among the food groups.

In general, consumption patterns in the temperate zone countries, namely Mexico in the north and Argentina, Chile, and Uruguay in the south, are superior to those situated in the tropical and sub-tropical regions. All the southern temperate zone countries benefit from extensive livestock industries. Brazil, situated almost entirely in the tropics, exhibits many similarities in consumption pattern to countries of similar latitude in subSahara Africa.

Within the Soviet Bloc, consumption patterns tend to be quite uniform but also monotonous. The share of calories contributed by the starchy food group amounts to over one-half in every country ranging from 51-52 percent in East Germany and Czechoslovakia to 74 percent in Bulgaria. The Soviet diet is quite starchy, mostly bread and potatoes. The starchy food group provides 67 percent of the food energy supply. Most of the countries in Latin America and many in Africa enjoy a better distribution among the food groups than do the Bloc countries.

Diets in Asia are almost universally characterized by extreme dependence on starchy foods. Israel and Singapore represent the only exceptions. Even Japan, with a relatively high standard of living otherwise, depends upon starches for 75 percent of its energy supply. The use of livestock products is quite low in Asia, mostly for economic reasons but in some countries, such as India, for religious reasons as well. Religious tenets probably influence food habits in India more than in any other country. In spite of the

religious restrictions on meat consumption, the share of calories derived from the use of livestock products is higher than in Indonesia, Burma, or Pakistan. The livestock share of total calories consumed in India is buoyed up largely by the use of milk and milk products, provided by the inordinately large cattle and buffalo population. Fish provide a larger share of total calories consumed in Japan, South Korea, and Thailand, than in other countries in the world. Japan and Korea, lacking the land to produce livestock and unwilling to use foreign exchange to import costly livestock products, have turned to the sea as a source of animal protein.

Man's Staple Foods

Food staples are defined simply as foods providing a large share of the total calories consumed in a particular country or region. Staples are customarily grains, roots or tubers but occasionally some other starchy food such as bananas qualifies as a staple. Sugar provides a sufficiently large share of calories in some countries such as Costa Rica and the Dominican Republic to rank as the principal food staple but it is not generally considered a staple and therefore is not included in this discussion. Some diets depend heavily on one staple food but more often diets are characterized by a combination of staples or substaples.

Rice and wheat are man's principal foods, rice supplying 21 percent of total calorie intake and wheat 20 percent (table 11). Together these two staples, providing 41 percent of man's food energy supply, completely dominate the world consumption pattern (fig. 11). Although rice currently supplies a slightly larger share of total calories than wheat, this may change as the densely populated, food deficit, rice eating countries become more dependent on food imports, mostly wheat. Stated otherwise, production potential seems much greater in the wheat producing regions.

The third and fourth ranking staples, corn and potatoes, each supply about 5 percent of all calories consumed. Sixty percent of man's food energy is supplied by the six leading grains and various roots and tubers listed as food staples.

Regional food staples

In the four geographic regions listed as developed, wheat is overwhelmingly the principal food staple (table 12). Asia is heavily dependent on rice, and Latin America on corn. In Africa corn and the millet and sorghum groups are of equal importance. Grains are,

Table 11.--World population distribution according to national food staple, 1958

Food staple	Countries	Number of people	Share of world population
	Number	Millions	Percent
Rice	16	1,476.4	53.7
Wheat	43	977.5	35.5
Corn	14	102.7	3.7
Cassava	6	90.1	3.3
Sorghum and millet	4	42.1	1.5
Potatoes	2	41.5	1.5
Teff[1]	1	18.4	0.7
Bananas and plantains	1	2.8	0.1
	87	2,751.5	100.0

[1] Teff is a grass producing a very small edible seed. It is not widely cultivated outside Ethiopia.

Source: Derived from Appendix table A-3.

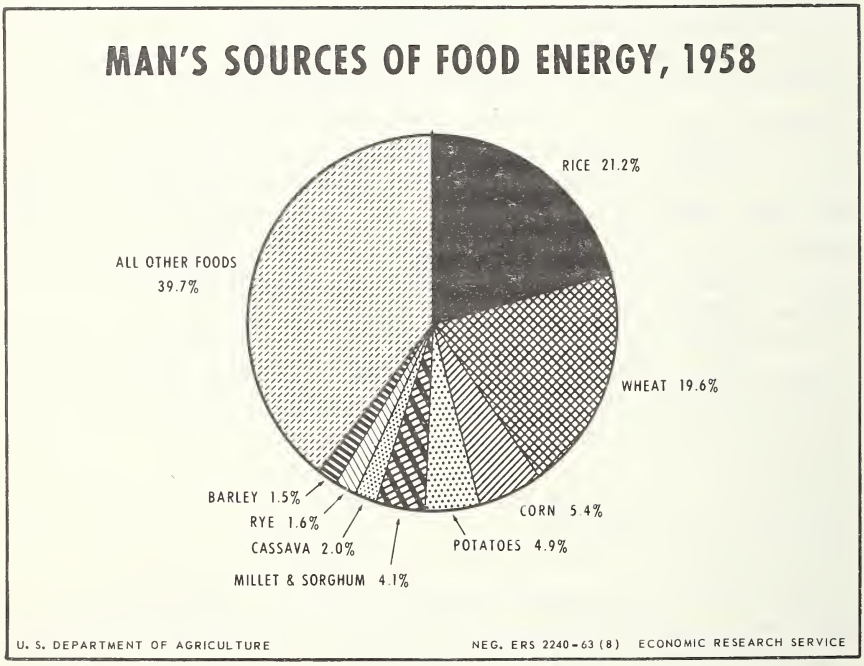

Figure 11

Table 12.--Percentage distribution of total calorie supply by principal food staples, by regions, 1958[1]

Region	Rice	Wheat	Corn	Potatoes[2]	Sorghum and millets	Cassava	Rye	Barley	All other foods	Total
	-Percent-									
Geographic regions										
North America...	.8	17.7	1.6	3.2	--	--	.2	.2	76.3	100.0
Oceania.....	.6	25.5	.5	3.0	--	--	--	([3])	70.4	100.0
Western Europe..	1.1	30.8	1.8	6.7	--	--	2.9	.2	56.5	100.0
Latin America...	7.4	14.0	17.3	3.2	.4	7.3	.1	.5	49.8	100.0
E. Europe & USSR	.7	41.7	1.5	9.2	.4	--	8.7	--	37.8	100.0
Africa[4].....	2.7	10.6	14.1	8.6	14.2	11.6	--	3.2	35.0	100.0
Asia.....	41.1	13.0	5.0	3.2	6.1	1.1	.1	2.4	28.0	100.0
World.....	21.2	19.6	5.4	4.9	4.1	2.0	1.6	1.5	39.7	100.0
Economic regions										
Developed regions.....	.9	31.7	1.6	6.7	.2	--	4.4	.1	54.4	100.0
Less developed regions.....	32.4	12.8	7.6	3.9	6.5	3.2	.1	2.3	31.2	100.0
Political regions										
Free World.....	17.6	17.3	5.9	4.2	5.0	3.1	.6	1.6	44.7	100.0
Communist Bloc..	28.1	23.7	4.6	6.3	2.8	--	3.4	1.4	29.7	100.0

[1] The sum of the first 8 columns of this table does not equal the first column of table 10 because data for some countries include small quantities of some of the 8 staples listed in an "other" category.
[2] Both white and sweetpotatoes. In Africa, yams and coco-yams are included.
[3] Less than .05 percent.
[4] Teff, the food staple of Ethiopia is included in "all other foods".

Source: U.S. Dept. Agr. Food Balances in Foreign Countries (19, 20, 21, 22).

in general, far more important than roots and tubers and although cassava or yams qualify as principal staples in individual countries, they do not rank very high on a regional basis.

Africa has a much wider distribution among food staples than any other region (fig. 12). Four commodities or groups, wheat, corn, cassava and sorghum and millets, each account for more than 10 percent of the calories supplied. This reflects not so much diversity within countries as the existence of two distinct subregions. These are essentially, North Africa where wheat is the dominant staple, and Sub-Sahara Africa, where roots and tubers and corn are leading staples. Roots and tubers combined supply 20 percent of the calories in Africa; a percentage twice as high as in any other region.

Latin America easily has the most even distribution among the three leading food grains--corn, wheat, and rice--each providing 17, 14 and 7 percent respectively of the energy supply.

Consumption of substaples such as cassava and millets and sorghum is confined entirely to the less developed regions. The number of staple foods consumed is much greater and the distribution among staples much more even in less developed regions than in developed, possibly because the "inferior" or less preferred

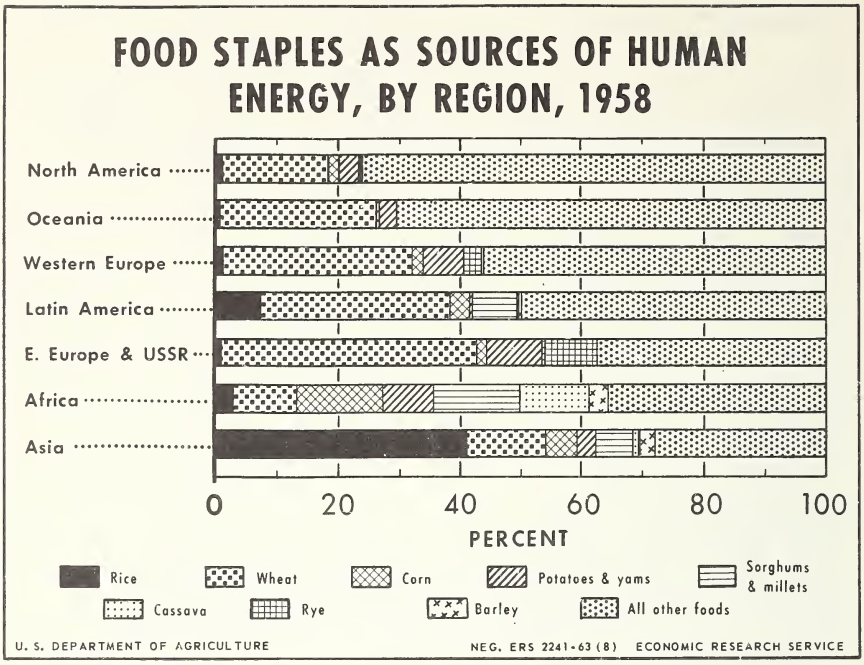

Figure 12

staples are not consumed at all in the developed regions. In the developed regions considered aggregately, wheat is the principal staple followed by potatoes as a substaple. Rice ranks first in the less developed world, largely because of Asia, and it is followed, in order, by wheat, corn, and millets and sorghums.

Country food staples

Forty-three countries depend upon wheat as the principal source of calories (table A-3). This compares with 16 countries for rice, 14 for corn, 6 for cassava, and 8 for the remaining assorted staples. Although more countries claim wheat as staple, rice is more important in terms of the number of people.

Fifty-four percent, or over half of the world's population, live in countries where rice is the staple food, and thirty-six percent or one-third, in countries where wheat is the staple food. The remainder live in countries having corn, cassava or some other food as the staple. Some countries, such as the Dominican Republic, deviate from the usual pattern and depend upon such nonconventional

staples as bananas and plantains as well as sugar. Another such country is Ethiopia, which depends on teff, a small edible grass seed. It is not widely cultivated outside Ethiopia.

Relative dependence upon the chief staple varies widely among countries. Some "mono-cultural" countries such as Burma and Thailand look to rice for 74 and 65 percent respectively of their calories. In general, those countries having very low levels of starch consumption or a very diverse selection of staples, are least dependent upon a particular staple. The United States and New Zealand could be an example of the former and Peru, Costa Rica or Ghana the latter.

Although the share of calories derived from starchy foods in a given country or region is largely a function of income, principal food staples are influenced more by geography. Physical conditions, not economic conditions, largely determine which staple will prevail. Wheat growing regions are wheat consuming regions and rice growing regions are rice consuming regions regardless of whether a country is in an early or advanced stage of development.

Nutritionally Inadequate Diets

Exact information on the number of people suffering from nutritionally inadequate diets does not exist. Most estimates of the extent of nutritional inadequacy stem from three sources and are consequently of three types. The first approach is that employed by economists using an empirical approach based on broad aggregations of data on food production, trade and availability. The second method, employed by teams of doctors, physiologists and nutritionists, usually involves detailed physical examination of a limited number of persons, with an eye to observing and recording symptoms of malnutrition. The third method--dietary surveys--are commonly used especially in countries where aggregate data are incomplete. These are often conducted on a household basis.

The first approach, that of the economists, has been used by research groups such as the Food and Agricultural Organization of the United Nations and the Regional Analysis Division of the Economic Research Service, United States Department of Agriculture. The second method of approaching the problem has been employed by the Interdepartmental Committee on Nutrition for National Defense of the U.S. Government. This procedure is described by Phipard and Shepherd in a recent paper:

> "The Inter-Departmental Committee on Nutrition for National Defense was established in 1955, for the purpose of providing assistance on nutrition problems of technical, military, and

economic importance in foreign countries. At the request of the countries, survey teams of U.S. specialists representing many disciplines (physicians, bio-chemists, laboratory technicians, nutritionists, dentists, food technologists and agricultural economists) have conducted nutrition surveys, as of July 1961 in 16 countries--5 in the Far East, 4 in the Near East, 4 in South America, 4 in Africa and 1 in Europe. The U.S. nutrition teams work side by side with their counterparts in the host countries and suggest many ways of making more effective use of the country's food resources. These surveys are continuing. The survey reports provide detailed information on the diets and nutritional status of the military forces and, in many of the countries, of civilian groups as well. They constitute an important resource for pinpointing nutritional problems." (52, p. 65)

This study, concerned primarily with the economic aspects of the world food problem, will employ the approach of the economists, more particularly those of the Regional Analysis Division as presented in the World Food Budget, since this provides data for all countries. Once food balance sheets have been constructed, per capita supplies of individual foods or groups are calculated in terms of national average quantity per capita. From these quantities estimates are made of the food energy, animal protein, pulse protein, total protein and fat provided by the diet. These figures are then compared with minimum reference standards established individually for each country or region (tables 13 and A-4). By means of this comparison it is possible to determine both the existence and the magnitude of any deficiency with respect to these broad indicators (fig. 13). It should be pointed out, however, that these are national averages and there are deficits within countries which are not revealed.

Table 13.--Daily per capita nutritional reference standards, by region or country

Country or region	Energy	Protein			Fat
		Animal	Animal plus pulse	Total (incl. other)	
	Calories	Grams	Grams	Grams	Grams
Canada	2,710	7	17	60	45
United States	2,640	7	17	60	44
Latin America	2,500	7	17	60	42
Mediterranean Europe	2,430	7	17	60	40
Other Western Europe	2,635	7	17	60	44
Soviet Union	2,710	7	17	60	45
Other Eastern Europe	2,635	7	17	60	44
Western Asia	2,400	7	17	60	40
Africa	2,375	7	17	60	40
Far East	2,300	7	17	60	38
Mainland China	2,300	7	17	60	38
Australia	2,640	7	17	60	44
New Zealand	2,670	7	17	60	44

Source: World Food Budget, 1962 and 1966, Econ. Res. Serv., U.S. Dept. Agr. 1961 (12).

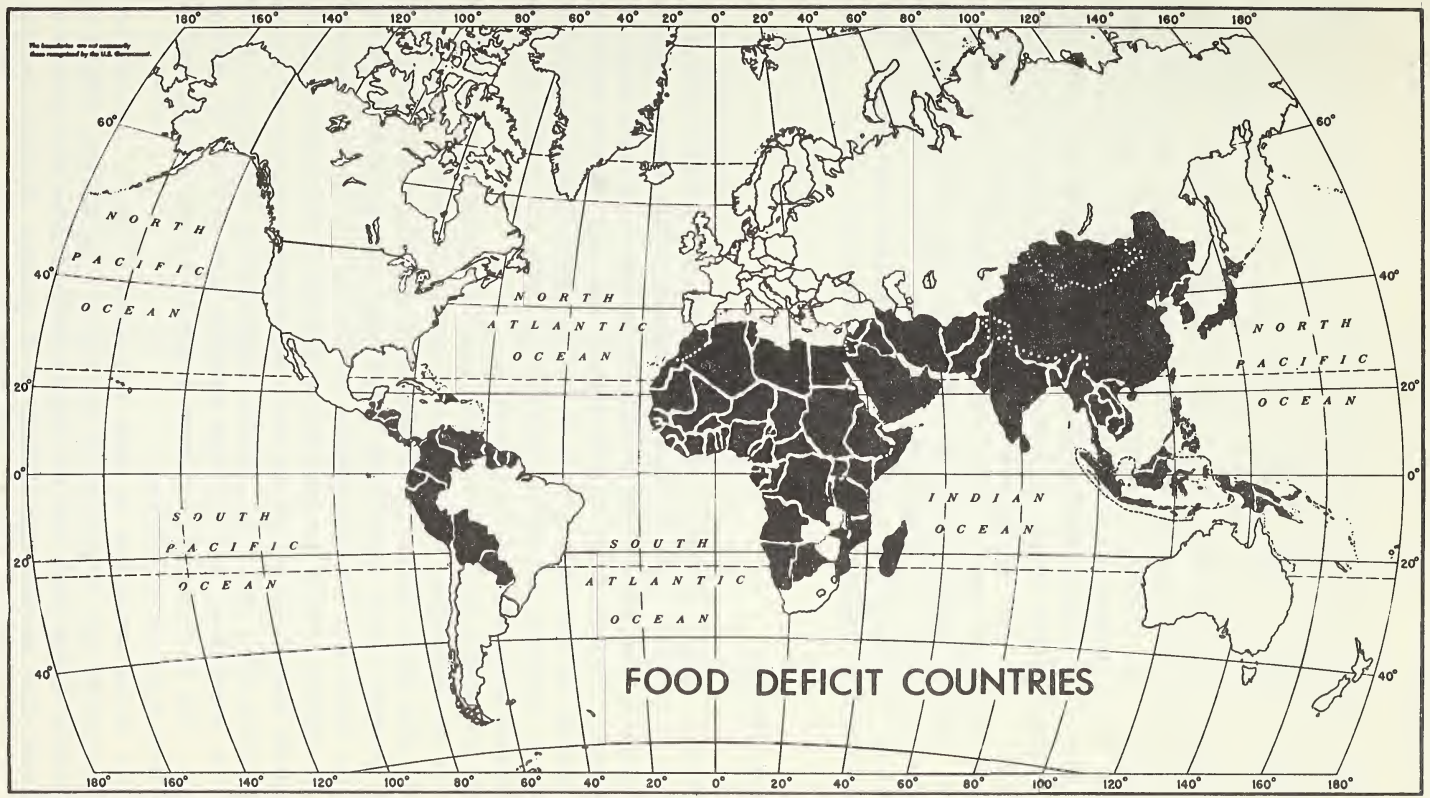
FOOD DEFICIT COUNTRIES
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
SOUTH ATLANTIC OCEAN
INDIAN OCEAN
U. S. DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE

Figure 13

Energy deficits

The level of food energy supply, usually measured in calories, is the most basic of all nutritional indicators. Part of man's energy intake is required to maintain life and provide for growth, and part to permit him to be physically active. All foods provide man with energy, although the energy content of different foods varies.

Energy requirements for a given country or region may vary with climate, average body size, and level of physical activity of the population. The calorie reference standards adopted for this study (World Food Budget) ranged from 2,300 for the Far East to 2,700 per capita for Canada and the Soviet Union. Thirty-six countries had energy supply levels below the recommended level in 1958 (table 14). All were in the three underveloped regions. The share of population of each region living in countries with average energy supply levels below the minimum recommended was 92 percent for Asia, 38 percent for Africa and 29 percent for Latin America. This amounts to 79 percent of the total population in the underdeveloped regions or 56 percent for the entire world.

Protein deficits

Protein supply provides a good indication of overall quality of diet. It is a much more complicated indicator than energy supply, for instance, because quality as well as quantity of protein must be considered. Protein from animal sources and from pulses improve the quality of the diet. Hence in setting up reference standards minimum amounts of these sources as well as of total protein availability were arbitrarily specified.

The per capita daily protein reference standards were uniformly set for all countries, at 7 grams of animal protein, 17 grams of animal plus pulse protein, and 60 grams of total protein including other protein. Latin Americans fared well with respect to animal protein. Haiti was the only country to fall short and it represented but 3.4 million people, or less than 2 percent of the regional total. Livestock husbandry is not so well developed in Africa and some 6 countries, all south of the Sahara, representing 26 percent of the region's population, had average national diet deficits in animal protein. The deficits ranged from 1 gram per person per day in Nigeria to 4 grams in Liberia.

Only three countries in Asia had animal protein deficits but they accounted for 73 percent of the region's population. India and Communist China each had per capita daily deficits of 1 gram and Indonesia had an average deficit of 3 grams. Current reports

Table 14.--Daily per capita consumption deficits of energy, protein, and fat, by countries, 1958

Country	Energy	Protein			Fat
		Animal	Pulse	Other	
	Calories	Grams	Grams	Grams	Grams
Latin America					
Argentina	--	--	--	--	--
Bolivia	620	--	--	10	14
Brazil	--	--	--	--	--
Chile	--	--	--	--	--
Colombia	275	--	--	9	--
Costa Rica	--	--	--	1	--
Cuba	--	--	--	--	--
Dominican Rep.	550	--	--	23	--
Ecuador	565	--	--	15	10
El Salvador	525	--	--	3	4
Guatemala	325	--	--	5	4
Haiti	625	3	--	15	20
Honduras	310	--	--	2	9
Mexico	--	--	--	--	--
Nicaragua	515	--	--	10	4
Panama	130	--	--	3	--
Paraguay	165	--	--	--	--
Peru	460	--	--	8	8
Uruguay	--	--	--	--	--
Venezuela	245	--	--	4	--
Africa					
Algeria	145	--	--	1	12
Angola	160	--	--	4	--
Belgian Congo & Ruanda-Urundi	--	--	--	11	3
Cameroun	--	2	3	4	--
Egypt	35	--	--	--	--
Ethiopia	80	--	--	--	--
Fr. Equat. Africa	--	--	--	4	13
Fr. West Africa	--	2	2	--	--
Ghana	--	--	3	6	--
Guinea	--	3	--	10	--
Kenya	135	--	--	--	3
Liberia	--	4	7	7	--
Libya	195	--	2	2	2
Morocco	--	--	--	--	10
Nigeria & British Cameroons	--	1	1	--	--
Rhodesia & Nyasaland	--	--	--	--	--
Sudan	80	--	--	--	--
Tanganyika	200	--	--	--	14
Togo	--	3	--	9	--
Tunisia	205	--	--	--	13
Un. of S. Africa	--	--	--	--	--
Asia					
Burma	150	--	--	9	12
Ceylon	240	--	5	9	--
Communist Asia[1]	100	1	--	--	6
India	250	1	--	2	4
Indonesia	175	3	--	9	--
Iran	360	--	--	--	10
Iraq	145	--	--	--	2
Israel	--	--	--	--	--
Japan	--	--	--	--	15
Jordan	315	--	--	--	3
Korea, South	260	--	--	--	19
Lebanon	--	--	--	--	--
Malaya, Fed. of	10	--	1	8	--
Pakistan	270	--	--	6	18
Philippines	155	--	--	4	--
Syria	145	--	2	--	--
Taiwan	--	--	--	--	1
Thailand	115	--	1	14	3
Turkey	--	--	--	--	--

[1] Mainland China, North Korea, North Vietnam.

Note: North America, Western Europe, E. Europe and USSR, and Oceania had no nutritional deficits.

Source: U.S. Dept. Agr. - The World Food Budget (12).

indicate a deterioration in the Chinese diet and therefore a much larger deficit in China now than in 1958. The number of people residing in countries with average national diets falling short in animal protein amount to approximately one-half of world population.

Pulse protein deficits pose a much less formidable problem than animal or total protein on a worldwide basis. In Latin America, where beans are common fare, the average per capita availability of pulse protein was more than adequate in every country. Asia, too, was rather well off with respect to pulse protein consumption; only 4 of the smaller countries, Ceylon, Malaya, Syria, and Thailand had less protein from pulses and animal sources than specified in the reference standards. Africa, showed up least well on this score with 6 countries including Nigeria, the largest, having pulse protein deficits. Although animal and pulse protein deficiencies were rather scattered, each showing up in the average national diets of only 10 countries, shortfalls in total protein intake were much more prevalent, occurring in some 31 countries. Thirteen out of 20 countries in Latin America had per capita protein supplies below the minimum recommended level. Per capita deficits in the Dominican Republic at 23 grams and Ecuador and Haiti at 15 grams per person per day were the most serious of any country anywhere. Deficits in total protein intake were quite common in Africa, occurring in 10 of 21 countries. Shortfalls were greatest in the cassava consuming East African countries south of the Sahara. Eight countries in Asia, including India and Pakistan, had deficit protein levels. China was not listed as a protein deficit country in 1958, an excellent harvest year, but by all odds, a sizeable per capita deficiency has developed over the last few years. The critical nature of the food situation in China is reflected in the decision to use scarce foreign exchange, needed for the industrialization program, to import food grains from Australia and Canada.

In all, diets in only 25 of the 60 countries in the underdeveloped regions of Asia, Africa, and Latin America could be classed as adequate by all three protein indicators. The remaining 35 countries, where average per capita consumption of animal, pulse or total protein was below the minimum recommended level, represented 79 percent of the population in the three underdeveloped regions or 56 percent of world population.

Fat deficits

Less is known about human requirements for fat than for any of the other nutritional indicators. It is known that some is required for proper functioning of the human body and, also, that too much can

be detrimental. For the purpose of evaluating diets, it was assumed that the fat supply should be sufficient to supply 15 percent of total calorie supply. Requirements for fat are then tied to consumption levels and the minimum per capita recommended levels vary from 45 grams per day in Canada and the Soviet Union to 38 in the Far East.

Eight Latin American countries have per capita fat supply levels below the minimum recommended. Three of these were the Andean countries of Bolivia, Ecuador and Peru while the remainder were situated in Central America and the Carribbean.

Fat deficits occurred in eight African countries, all well scattered about the continent. With the exception of Morocco, every country which was low in fat consumption was also deficit according to at least one of the other nutritional indicators.

Exceptionally low fat consumption was commonplace in Asia. Both India and China, the two population giants, as well as nine smaller countries fell short. Even Japan, where diets were up to standard, as measured by all other indicators, fell substantially short in fat consumption. Ninety percent of Asia's population is included in those countries with fat intake below reference standards.

Income and Quality of Diets--An International Cross Section

Three methods are available for examining the relationship between level of income and quality of diets. The first consists of comparing diets in countries having widely varying levels of income. The second involves studying the relationship between diets and income within a given country over a long period of time. Another is a cross section study within one country with all economic and social factors controlled except income.

Income levels strongly influence both quantity and quality of food consumed or, stated otherwise, income tends both to determine the level of consumption and to shape the consumption pattern. Data on average per capita incomes by country are available for a large number of countries with widely varying incomes. Food consumption data are likewise available for a large number of countries. It is obvious that at successively higher income levels certain changes take place in both consumption patterns and level of consumption. It is also obvious that changes in diet associated with rising income occur in a fashion which can be predicted with a useful degree of certainty.

This predictability of consumption patterns based on income changes applies more to the broad food groups such as grain products, fats and oils, livestock products, etc., than to the specific

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Table 15.--Per capita income estimates, by countries, 1959[1]

Country	Annual income	Country	Annual income
	Dollars		Dollars
North America[2]		Africa[5]	
Canada	1,531	Algeria	228
United States	2,250	Egypt	117
		Ethiopia	38
Latin America[3]		Ghana	144
Argentina	302	Guinea	68
Brazil	167	Kenya	86
Chile	439	Liberia	105
Colombia	200	Libya	114
Costa Rica	342	Morocco	121
Cuba	334	Nigeria	67
Ecuador	171	Sudan	64
El Salvador	176	Tanganyika	51
Guatemala	148	Togo	84
Honduras	170	Tunisia	133
Mexico	262	Rep. of So. Africa	348
Panama	332		
Paraguay	120	Asia[3]	
Peru	116	Burma	45
Venezuela	871	Ceylon	118
		China (Taiwan)	85
Western Europe[4]		India	62
Austria	588	Israel	831
Denmark	985	Japan	281
France	876	Malaya, Fed. of	224
Germany, West	925	Pakistan	51
Greece	304	Philippines	146
Iceland	524	Turkey	145
Ireland	491		
Italy	467	Oceania[2]	
Netherlands	775	Australia	1,095
Norway	900	New Zealand	1,244
Portugal	210		
Spain	246		
Switzerland	1,337		
United Kingdom	1,034		
Yugoslavia	156		

[1] Per capita income unadjusted for inequalities in purchasing power among countries.
[2] Obtained from national income data and official exchange rates published in International Financial Statistics, Vol. 15, No. 8, Aug. 1962.
[3] Per capita income figures obtained by converting per capita gross national product figures published in Selected Economic Data for the Less Developed Countries Office of Statistics and Reports, ICA, June 1961 to per capita income by means of the NI/GNP ratio in the source mentioned in footnote 2.
[4] Same method as described in footnote 3 except GNP data were taken from economic data sheets distributed by the Office of Statistics and Reports, AID.
[5] Method same as described in footnote 3 except a constant NI/GNP ratio was used for all countries.

foodstuffs such as rice, corn or wheat. This latter distinction, whether the commodity be rice or wheat, in grains, or peanut oil or soybean oil, in fats and oils, etc., seems to be subject more to the dictates of geography than income.

As incomes move up the scale, three easily discernible shifts in the income-consumption relationship occur. The level of food consumption trends upward, at least in the lower income ranges; the consumption pattern undergoes certain predictable changes toward more expensive foods; and the share of income spent for food declines (fig. 14).

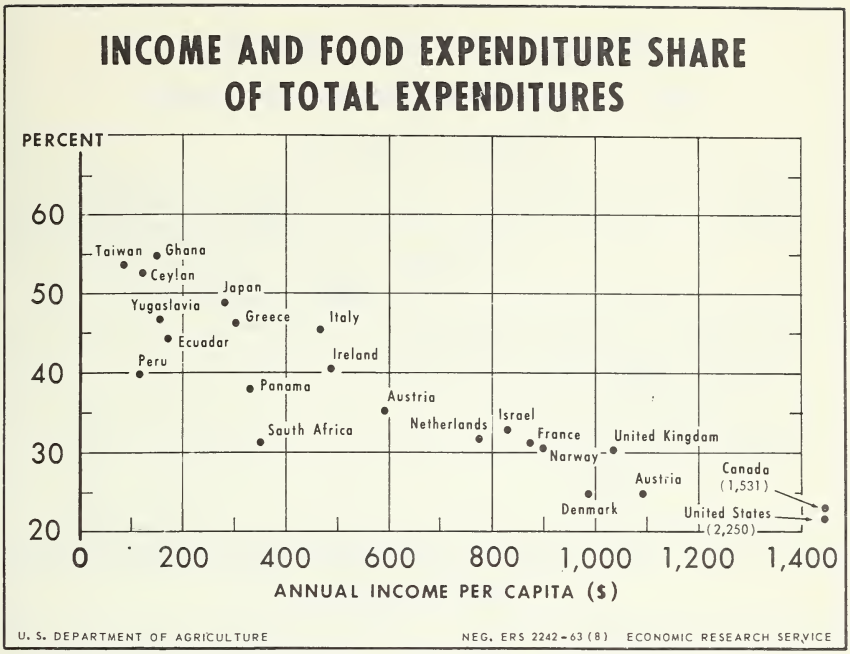

Figure 14

It has long been assumed that as incomes rise, the nutritional quality of diets improves. Ample evidence supporting this hypothesis is demonstrated by the fact that none of the countries in the four geographic regions classified as developed had any nutritional inadequacies, as measured by the five nutritional indicators mentioned earlier. Also supporting this hypothesis is the fact that the great majority of the countries in the three geographic regions listed as less developed have diets inadequate by at least one of the five nutritional indicators.

Some nutritional indicators are linked much more closely with level of income than others. The level of calorie intake is not a very sensitive indicator of income levels; in fact, after a point, per capita daily consumption may trend downward at successfully higher income levels (fig. 15). Perhaps a better nutritional indicator would be the consumption of "original calories". This measurement would reflect the shift from starchy foods to livestock products since it takes into account not the calories actually contained in the meat, milk or eggs but those contained in the feed grains required to produce the livestock products. The ratio between the original calories and those actually derived from livestock products

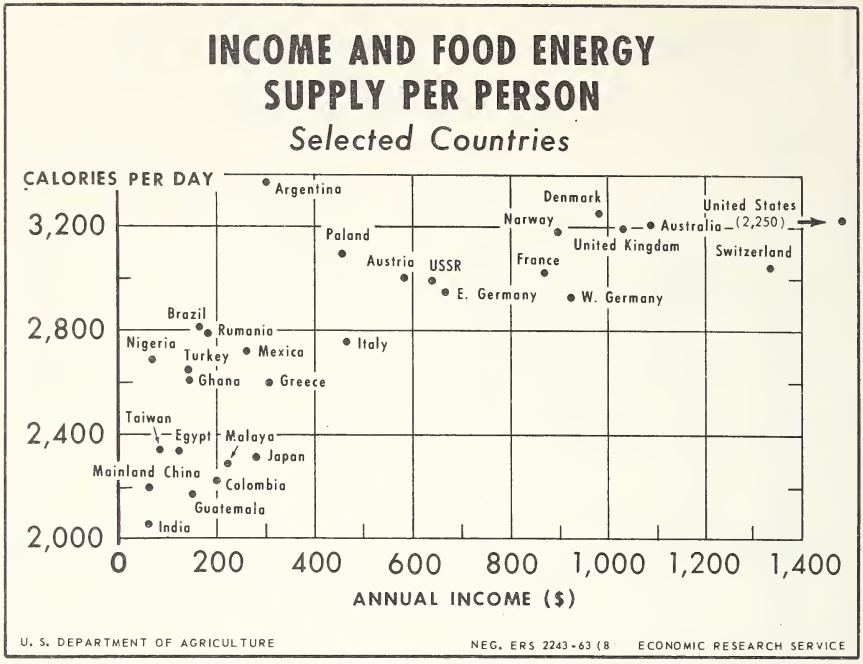

Figure 15

actually consumed is usually assumed to be seven to one. If animal products supply 1,000 calories of a 3,000 per capita daily intake then the total per capita daily consumption of original calories would be 9,000. This technique provides not only a more useful indicator of quality of diet but also a much better idea of the resource requirements for a particular pattern of consumption.

Where income is low, as in Asia, Africa or Latin America, cheap energy foods such as grains completely dominate the consumption pattern, often accounting for 60 to 80 percent of total caloric intake (fig. 16). The availability of livestock products in these circumstances is usually quite low and protein deficiencies are commonplace. As incomes rise, the consumption of livestock products is characteristically one of the first items to begin to increase. The consumption of fats and oils, too, is closely associated with income.

The per capita supply of food energy is nearly twice as high in some countries as in others. National averages range from just under 1900 calories per person a day in Bolivia and Haiti to almost 3400 in Ireland. The calorie level rises rapidly as incomes go from $60 to $300. After this, food energy levels are not so

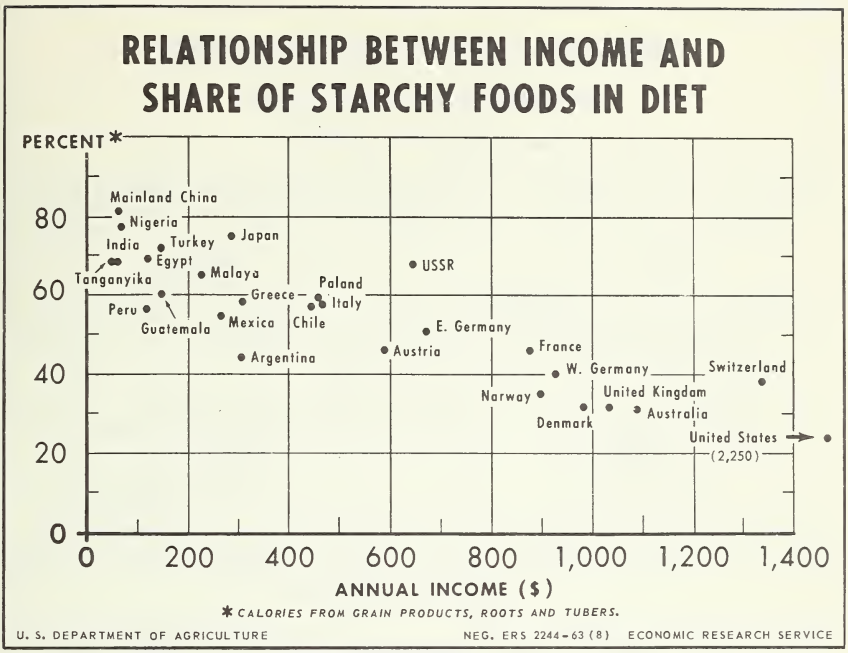

Figure 16

responsive to income change and after incomes reach $1,000 per capita, there seems to be little, if any, increase in calories associated with further increases in income. There may, in fact, be a tendency, often for reasons other than income for per capita food supply measured in calories to decline, as has recently been demonstrated in the United States.

The share of food energy derived from the consumption of grain products, roots and tubers ranging from about 80 percent in countries like Communist China to as low as 24 percent in the United States, decreases as incomes rise. Unlike the level of calorie consumption, the share of calories from starches seems to continue to decline rather steadily throughout the entire income range.

Protein intake is quite responsive to income (fig. 17). The per capita daily supply ranges from 42-50 grams in some of the lower income countries of Latin America to around 100 in Argentina, Australia and the United States. Argentina's uncommonly high intake of protein is ostensibly possible because of the generally high level of food intake and relative abundance of livestock products. Protein intake rises rapidly with income until incomes reach $300 per capita after which, the relationship is much less obvious.

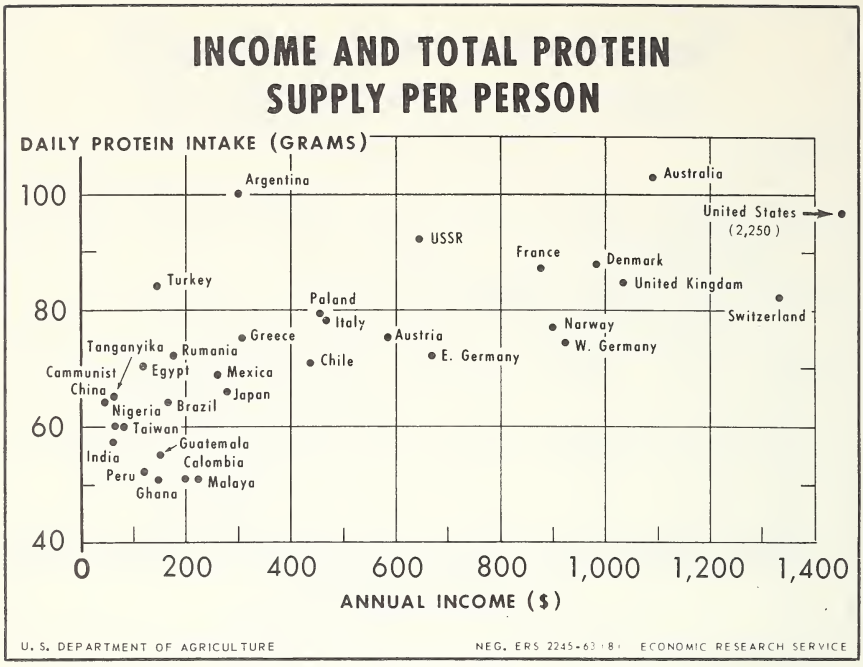

Figure 17

Consumption of animal protein shows a much closer relationship with income than any other nutritional indicator discussed (fig. 17). It ranges from a low of 3 grams per person per day in Liberia and Nigeria to a high of almost 70 or more grams in the United States and Australia. This 23 to 1 ratio between the highest and lowest compares with 2-3 to 1 for total protein and 2 to 1 for total calories. Animal protein is very costly and consumption can rise only as incomes permit; persons in low income countries can afford only minimal amounts (fig. 18).

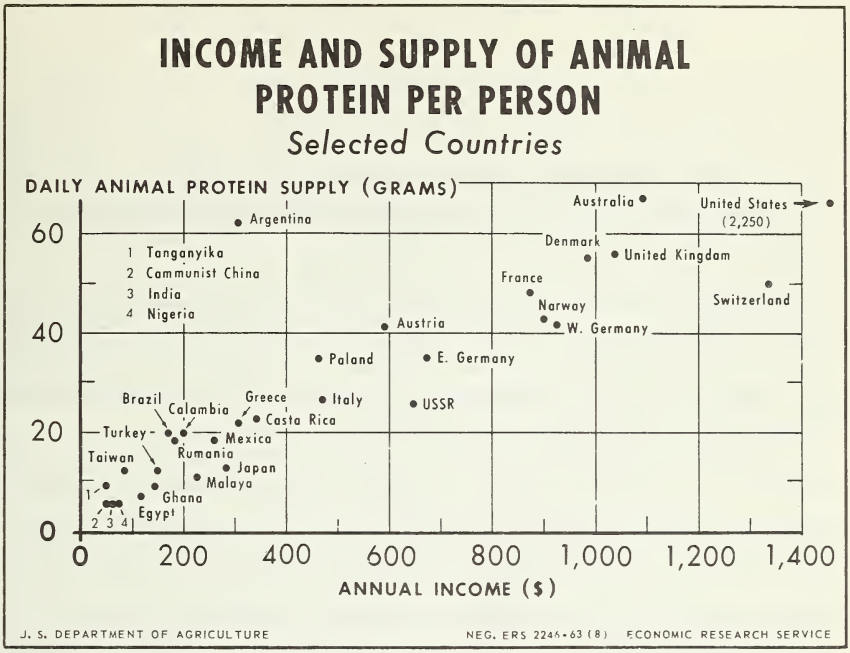
INCOME AND SUPPLY OF ANIMAL PROTEIN PER PERSON
Selected Countries
DAILY ANIMAL PROTEIN SUPPLY (GRAMS)
60
40
20
0
1 Tanganyika
2 Communist China
3 India
4 Nigeria
Argentina
Australia
United States
(2,250)
Denmark
United Kingdom
France
Norway
W. Germany
Switzerland
Austria
Poland
E. Germany
Brazil
Colombia
Greece
Italy
USSR
Costa Rica
Turkey
Mexico
Rumania
Taiwan
Japan
Malaya
Ghana
Egypt
0
200
400
600
800
1,000
1,200
1,400
ANNUAL INCOME ($)
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 2246-63 (8) ECONOMIC RESEARCH SERVICE

Figure 18

Chapter V.--GRAIN PRODUCTION: A SIMPLIFIED FOOD OUTPUT INDICATOR

Throughout much of this study, grain production will be considered representative of total agricultural production. Admittedly, it is not as comprehensive or detailed as total agricultural output, but, within the scope of this study, the gain in conceptual precision more than offsets any loss in comprehensiveness.

As pointed out in Chapter IV, seventy-one percent of the world's cropland is used to produce grains. The direct consumption of grains provides 53 percent of man's calorie supply and indirect consumption, in the form of meat, milk, eggs, and other livestock products, accounts for a large part of the remaining calorie intake. The per capita availability of grain largely determines the quality of diet. If availabilities are low, virtually all grains must be consumed directly to satisfy man's minimal energy requirements. But if they are high, a substantial portion may be fed to livestock and converted into meat, milk, and eggs so essential to a nutritionally adequate diet. The per capita availability of grain, then, is a useful indicator of the nutritional quality of diets. It is also a very useful analytical tool for it is now possible to make meaningful comparisons between regions and, perhaps more importantly, within any given region over a long period of time.

An analysis of trends in arable land area by region is difficult because of variations between countries within a given region in definitions and in available data. In addition, data are often available only for census years and, historically, these have varied greatly from country to country. Relatively reliable data are available, however, for area in grain for every country of significant size. Area planted to grain is conceptually much more uniform and therefore much more useful in examining long term trends.

Once reasonably reliable and comparable data are available for grain output and planted area, an analysis of long-term yield trends becomes relatively easy. Since grains are rather uniform it is possible to aggregate all grains on a tonnage basis. Yields may then be compared between regions or historically within a given region. Were all agricultural commodities to be included, aggregation of all crops to measure yields and trends would become an almost impossible task.

Grain Production Trends by Region

World grain output increased 47 percent from 1934-38 to 1960/61 (table 16). During this period output increased in every geographic region but at widely varying rates (table 17). Oceania and North America, both at least doubling total grain production, made far more impressive gains than any other region. Eastern Europe and the Soviet Union, with a gain of only 24 percent for the 25-year span, was even less successful than the three less developed regions of Asia, Africa and Latin America. Both Western Europe and the Soviet Bloc suffered serious setbacks during World War II and it was not until the early 1950's that prewar levels were regained. Progress in Asia and Latin America was also slowed by the war. Africa seemed little affected during the troublesome decade of war and reconstruction as its output of grains gained rather steadily from 1934-38 to 1960/61.

North America and Oceania both made rapid gains throughout the period, with North America moving somewhat faster until 1960/61 when Oceania's output was given a strong boost by an uncommonly good year in almost every respect. Oceania's gains, though striking from a percentage point of view, are made from a very small base, amounting to only 5 million tons in 1934-38 or less than 1 percent of world output.

North America expanded its share of world grain output from 16.7 percent in the base period to 22.8 percent in 1961. The Soviet Bloc share of world output was steadily shrinking during the same period going from 23.5 to 19.8 percent.

If world grain output is viewed in terms of the two dominant economic regions--developed and less developed--the trends in aggregate output are quite similar. Output in the developed regions increased 51 percent during the period under survey while that in the less developed regions was only somewhat less at 42 percent. It must be pointed out, however, that the rapid population growth in the less developed regions makes per capita output compare much less favorably. Aggregate output in the developed regions amounted to 334 million metric tons in 1934-38 compared with 317 million tons in the less developed regions. By 1960/61 the margin had increased slightly as output reached 506 and 450 million tons respectively in the two regions.

When the world is viewed in terms of the principal political regions, the Free World and the Communist Bloc, aggregate grain production trends diverge considerably. During the period under survey, gains amounted to 59 percent in the Free World but only 29 percent in the Bloc countries. Free World gains tended to be spread throughout the entire period, although concentrated somewhat

Table 16.--World grain: Indexes of total harvested area, production and yield, average 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61 (1934-38 = 100)[1]

Item	1934-38	1948-52	1957/58-59/60	1960/61
Total production.....	100	109	137	147
Total harvested area...	100	107	113	115
Average yield.....	100	102	122	128

[1] Differences in year notation for production, acreage, and yield are more apparent than real. The FAO Production Yearbooks (15), the source of most of the regional data, have changed from the calendar year to the split year. The split year more explicitly identifies the crop harvest year when both the Northern and Southern Hemispheres are involved. Under the notation system used for earlier years 1960/61 would appear as 1960.

Source: Tables 17, 19, and 21.

Table 17.--World grain production, by regions, averages 1934-38, 1948-52 1957/58 - 59/60 and annual 1960/61

Region	1934-38	1948-52	1957/58-59/60	1960/61
	Million metric tons			
Geographic regions				
North America.....	109	169	199	218
Latin America.....	31	31	42	44
Western Europe.....	67	65	84	88
E. Europe & USSR.....	153	134	177	189
Africa.....	26	32	38	40
Asia.....	260	272	348	366
Oceania.....	5	7	7	11
World.....	651	710	895	956
Economic regions				
Developed regions.....	334	375	467	506
Less developed regions.....	317	335	428	450
Political regions				
Free World.....	385	453	562	613
Communist Bloc.....	266	257	333	343
	Indexes (1934-38 = 100)			
Geographic regions				
North America.....	100	155	183	200
Latin America.....	100	100	135	142
Western Europe.....	100	97	125	131
E. Europe & USSR.....	100	88	116	124
Africa.....	100	123	146	154
Asia.....	100	105	134	141
Oceania.....	100	140	140	220
World.....	100	109	137	147
Economic regions				
Developed regions.....	100	112	140	151
Less developed regions.....	100	106	135	142
Political regions				
Free World.....	100	118	146	159
Communist Bloc.....	100	97	125	129

Source: FAO Production Yearbooks (15).

in more recent years. Gains in the Bloc countries however were confined almost entirely to the mid-1950's, over the last few years gains in aggregate output have been minimal, not beginning to keep pace with population.

Per Capita Grain Production Trends

Per capita grain production trends are useful indicators of both agricultural progress and quality of diets. Grains supply a majority of all calories consumed, either directly or indirectly after conversion into meat, milk, or eggs. Rising per capita output of grains makes possible either a rise in calorie consumption or the conversion of grain into livestock products if additional animal protein is needed or desired.

Grain output per capita trended upward on a world basis for the period 1934-38 to 1960/61, increasing from 307 to 328 kilograms per year, an improvement of 7 percent (table 18). Individual geographic regions, however, showed very divergent trends. Per capita output actually declined 16 percent in Latin America and 2 percent in Asia. Western Europe, the Soviet Bloc and Africa enjoyed modest gains of 19, 5 and 8 percent respectively. Spectacular gains were made by Oceania and North America as per capita output climbed 51 and 44 percent respectively. North American gains were rather even throughout the period whereas those made in Oceania occurred mostly at the end of the period.

If the world is divided into developed or less developed regions, two divergent trends are evident. The more developed countries increased per capita output from 470 to 593 kilograms per capita a year--a rise of 26 percent. The less developed regions started at 224 kilograms per capita and dropped sharply during and after World War II. During the 1950's output per person trended upward but by 1960/61 it was still only 218 kilograms per year, 3 percent below prewar.

The gap between per capita grain output in the developed and less developed regions of the world was 246 kilograms during the prewar period; it grew steadily during the next two decades reaching 375 kilograms in 1960/61. The gap had expanded by 129 kilograms or an average of 5 kilograms per year.

When agricultural progress is viewed in terms of the two major political regions, the Free World and the Communist Bloc, divergent trends are again evident. Free World per capita output, going from 278 to 319 kilograms, registered a gain of 15 percent. In the Communist Bloc, output declined from 359 to 345 kilograms per capita, a fall of 4 percent.

Table 18.--Per capita grain output for total population, by regions, averages 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61

Region	1934-38	1948-52	1957/58-59/60	1960/61
	Kilograms			
Geographic regions				
North America	768	1,006	1,042	1,107
Latin America	254	190	213	214
Western Europe	247	234	284	293
E. Europe & USSR	533	453	535	558
Africa	158	161	167	170
Asia	231	197	221	226
Oceania	455	538	467	688
World	307	284	316	328
Economic regions				
Developed regions	470	497	559	593
Less developed regions	224	192	214	218
World	307	284	316	328
Political regions				
Free World	278	275	301	319
Communist Bloc	359	301	345	345
World	307	284	316	328
	Indexes (1934-38 = 100)			
Geographic regions				
North America	100	131	136	144
Latin America	100	75	84	84
Western Europe	100	95	115	119
E. Europe & USSR	100	85	100	105
Africa	100	102	106	108
Asia	100	85	96	98
Oceania	100	118	103	151
World	100	93	103	107
Economic regions				
Developed regions	100	106	119	126
Less developed regions	100	86	96	97
World	100	93	103	107
Political regions				
Free World	100	99	108	115
Communist Bloc	100	84	96	96
World	100	93	103	107

Source: Tables 1 and 17.

Prior to World War II the Communist Bloc enjoyed an advantage in per capita grain output per year of 81 kilograms but this advantage almost disappeared as output per person declined in the Bloc while making impressive gains in the Free World. To offset the effect of this per capita output decline, the Bloc, traditionally a net exporter of grains, became a net importer, importing an average of 2 kilograms per capita in 1960/61.

In summary, five of the seven geographic regions made per capita output gains. These included the four developed regions, and Africa, classified as less developed. Greatest gains on an absolute basis were in North America where output per person expanded 339 kilograms--more than total per capita output in the less developed regions. Those regions experiencing declines in per capita output were Latin America, losing 40 kilograms per capita annually, and Asia, losing 5 kilograms.

Table 19.--World grain area, by regions, average 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61[1]

Regions	1934-38	1948-52	1957/58-59/60	1960/61
	Million acres			
Geographic regions				
North America	245	257	237	235
Latin America	67	69	88	89
Western Europe	105	96	100	100
E. Europe & USSR	357	326	376	367
Africa	97	111	119	125
Asia	511	616	646	674
Oceania	16	15	17	21
World	1,398	1,490	1,583	1,611
Economic regions				
Developed regions	723	694	730	723
Less developed regions	675	796	853	888
Political regions				
Free World	861	917	986	1,010
Communist Bloc	537	573	597	601
	Indexes (1934-38 = 100)			
Geographic regions				
North America	100	105	97	96
Latin America	100	103	131	133
Western Europe	100	91	95	95
E. Europe & USSR	100	91	105	103
Africa	100	114	123	129
Asia	100	121	126	132
Oceania	100	94	106	131
World	100	107	113	115
Economic regions				
Developed regions	100	96	101	100
Less developed regions	100	118	126	132
Political regions				
Free World	100	107	115	117
Communist Bloc	100	107	111	112

[1] See footnote 1 table 16 and footnote 4 (this chapter)

Source: FAO Production Yearbooks (15).

Regional Trends in Grain Area[4]

It is often assumed that as population grows, more and more land is brought under cultivation to meet growing food needs. This is no longer always the case, however, for in two major regions, Western Europe and North America, the area used to produce grains has gradually declined over the past quarter century. In North America the area has declined from 245 to 235 million acres or 4 percent while in Western Europe the area has declined from 105 million acres to 100 million, a drop of 5 percent (table 19).

[4] Statistics for area of grain refer in most countries to harvested area or to area in cultivation on a specific date between planting and harvest. Only a few countries have statistics on both planted and harvested area; for such countries, harvested area is used.

The area planted to grain in the Soviet Bloc was down considerably during and immediately after World War II. As the "virgin lands" project got underway in the Soviet Union the area expanded during the middle and late 1950's but then was cut back somewhat in 1960/61. Net gains during the quarter century amounted to only 3 percent.

The three less developed regions--Asia, Africa, and Latin America--as well as Oceania all expanded their planted area about 30 percent each. World-wide increases for this period amounted to 213 million acres or 15 percent. By far the greatest part of this world gain in planted area, 163 of the 213 million acres, occurred in Asia.

An examination of trends in the area planted to grain showed that in the developed regions the area has remained quite constant and in fact was exactly the same in 1960/61 as in 1934-38. The trend in the less developed regions was quite different for they expanded planted area some 32 percent during this period. During the 1934-38 period, 723 million acres of grain were planted annually in the developed regions but only 675 in the less developed regions. By 1960/61, however, with the planted area remaining static in the developed regions while growing steadily in the less developed regions, the situation had been reversed with 723 million and 888 million acres planted respectively.

The difference between trends in the planted area between the Free World and the Communist Bloc is much less pronounced. Both regions increased planted area rather steadily with the Free World increasing a total of 17 percent compared with 12 percent in the Bloc Countries.

Per Capita Trends in Grain Area

Although the harvested area of grain expanded from 1.4 billion acres in 1934-38 to 1.6 billion in 1960/61, it did not increase as rapidly as population and there was thus a decline in grain producing land per capita. The average per person on a worldwide basis was .66 acres in 1934-38 but only .55 acres in 1960/61, a decline of 17 percent (table 20).

Per capita declines were experienced in all areas but they were more pronounced in some than in others. In North America, where the total grain area has actually declined while population continued to grow, the per capita decline was most pronounced. This region ranked first in grain area per capita in 1934-38 but was displaced in 1960/61 by Oceania where the expansion in planted area has more nearly kept pace with population growth.

Table 20.--Per capita grain area, by regions, averages 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61

Region	1934-38	1948-52	1957/58-59/60	1960/61
	Acres			
Geographic regions				
North America	1.73	1.53	1.24	1.19
Latin America	.55	.42	.45	.43
Western Europe	.39	.35	.34	.33
E. Europe and USSR	1.24	1.10	1.14	1.08
Africa	.59	.56	.52	.53
Asia	.45	.45	.41	.42
Oceania	1.45	1.15	1.13	1.31
World	.66	.60	.56	.55
Economic regions				
Developed regions	1.02	.92	.88	.85
Less developed regions	.48	.46	.43	.43
World	.66	.60	.56	.55
Political regions				
Free World	.62	.56	.53	.53
Communist Bloc	.72	.67	.62	.61
World	.66	.60	.56	.55

Source: Tables 1 and 19.

Three regions, North America, Oceania, and the Soviet Bloc, are well endowed with grain producing land, each having more than one acre per capita. The other four regions are much less fortunate in this respect, for their per capita availability of grain producing land is much less, ranging from about one-half acre in Africa to one-third acre in Western Europe. With the exception of Western Europe all the developed regions now have one acre per capita or more while all the less developed regions have one-half acre or less.

Both North America and Oceania produced large surpluses of grain which flowed into Western Europe and the land-scarce, less developed regions. The Soviet Bloc, with its generous land endowment, was once the major surplus grain producing area. It has not been able to maintain its position, however, and has in fact emerged as a deficit area over the past few years.

It should be pointed out here that the regions with the greater availabilities of grain-producing land per capita (North America and Oceania) tend to produce at much lower cost than those where per capita availabilities are limited (Western Europe and Asia). This broader approach strongly supports the conclusions reached as a result of correlating arable land per capita and the grain production cost by country in the section entitled "The Rising Cost Curve." (p. 94)

A comparison between the developed and less developed regions of the world shows that although per capita grain area has declined slightly faster in the developed countries, the 2 to 1 advantage in the developed regions has been essentially maintained throughout the period under study.

Regional Trends in Grain Yields

Grain yields increased in every region during the period under survey but at widely varying rates (table 21). At one end of the spectrum are Asia and Latin America gaining 7 and 8 percent respectively, and at the other end is North America where yields increased 109 percent. No region came close to approaching North America's spectacular gains in yields.

The wide difference between the rates of increase in yield changed the ranking of the regions according to yields. In 1934-38, Western Europe, with 638 kilograms per acre had the highest yields. It was followed in order by Asia, Latin America, and North America. By 1960/61 yields had more than doubled in North America and it was in first place with 927 kilograms per acre as compared with 876 for Western Europe, now the second ranking region (fig. 19).

In general the greatest gains in yields were made by the developed regions. The Soviet Bloc was the sole exception. A rise in capital inputs seems to be the major factor accounting for the higher yields. The diverging yields between the more and the less developed

Table 21.--Grain yield per acre harvested, by regions, average 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61

Region	1934-38	1948-52	1957/58-59/60	1960/61
			Kilograms	
Geographic regions				
North America	[1] 443	659	839	927
Latin America	461	450	480	498
Western Europe	638	676	833	876
E. Europe & USSR	429	408	470	514
Africa	265	287	316	318
Asia	508	441	538	542
Oceania	331	444	435	535
World	465	475	565	593
Economic regions				
Developed regions	462	538	639	699
Less developed regions	468	420	501	506
Political regions				
Free World	446	493	569	606
Communist Bloc	495	447	557	571
			Indexes (1934-38 = 100)	
Geographic regions				
North America	100	149	189	209
Latin America	100	98	104	108
Western Europe	100	106	131	137
E. Europe & USSR	100	95	110	120
Africa	100	108	119	120
Asia	100	87	106	107
Oceania	100	134	131	162
World	100	102	122	128
Economic regions				
Developed regions	100	116	138	151
Less developed regions	100	90	107	108
Political regions				
Free World	100	111	128	136
Communist Bloc	100	90	113	115

Derived from tables 17 and 19.

[1] It should be noted here that drought conditions in North America in 1934 and 1936 reduced grain yields somewhat, average yields for this period being about 10 percent below those for the 1928-32 period.

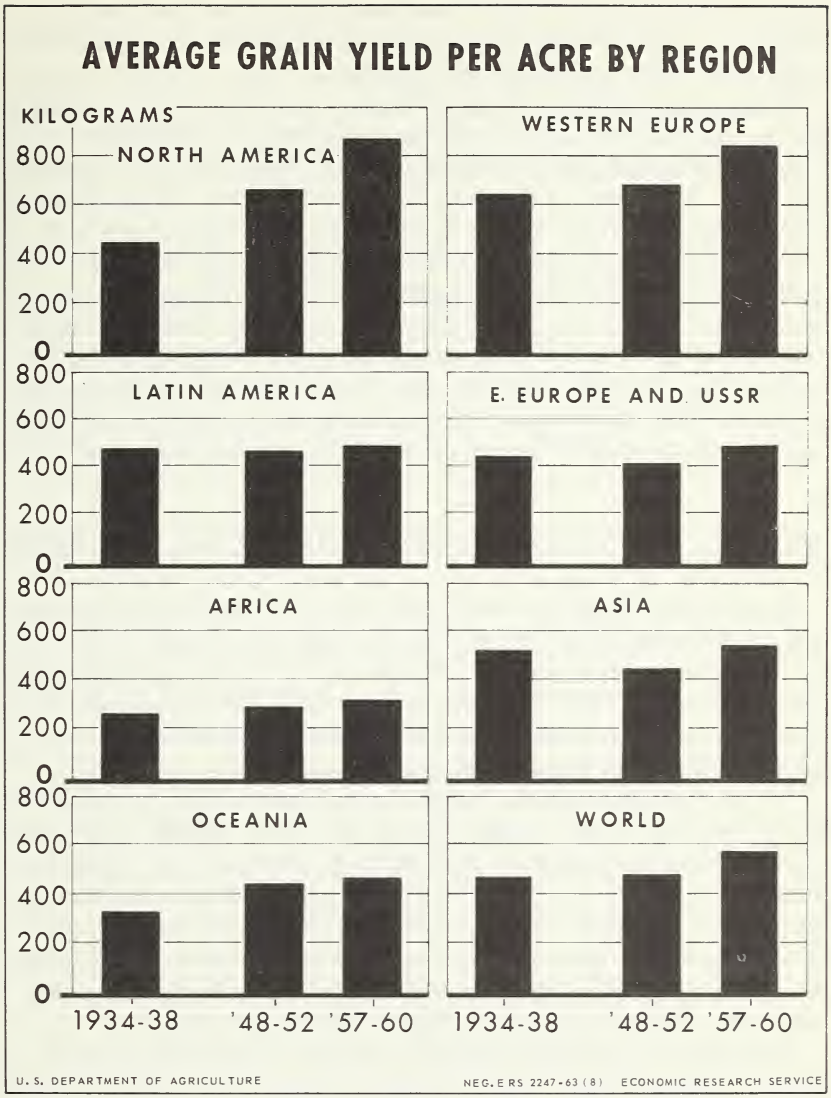

Figure 19

areas are thus readily explained; the developed regions have had capital available for investment in agriculture and the less developed regions have not.

Also affecting yield trends were the trends in cultivated land area. Where the amount of land per capita for grain output was limited, as in the less developed regions, any addition to the planted area was probably of marginal quality. In those regions such as

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North America and Western Europe where the area planted to grain declined, it is quite likely that the land withdrawn from production was of less than average productivity.

World grain yields increased 28 percent from 1934-38 to 1960/61 but as mentioned earlier these gains were concentrated in the developed regions. Here they gained 51 percent as compared with a meager 8 percent in the less developed portions of the world. In 1934-38, yields were higher in the less developed regions by 468 to 462 kilograms per acre. By 1960/61 however, the more developed regions had achieved an average yield of 699 kilograms per acre as compared with only 506 in the less developed regions. Gains in yields have been twice as great in the Free World as in the Communist Bloc. In 1934-38 the Bloc countries had a slight edge in yields of 495 kilograms per acre as compared with 446. By 1960/61, however, the Free World had an advantage of 606 kilograms to 571.

Summary of Trends in Production, Area, and Yield

World output of grain increased from 651 million metric tons in 1934-38 to 956 million tons in 1960/61. This represented an increase of 47 percent. Area expanded 15 percent and yields went up 28 percent; thus during this quarter century span about one-third of the expansion in grain output was attributable to expansion of area and about two-thirds to higher yields (table 16).

On a per capita basis, output increased 7 percent, going from 307 to 328 kilograms. These gains were quite unevenly distributed between regions, however, and while the per capita output in the developed regions was gaining 26 percent it was simultaneously declining 3 percent in the less developed regions. A similar divergence exists when political regions are compared. While output per person was gaining 14 percent in the Free World countries, it was in fact declining 4 percent in the Communist Bloc.

The land area planted to grain went from 1.4 to 1.6 billion acres between 1934-38 and 1960/61. This represented a 15-percent gain but it was much less than world population growth and grain land per capita meanwhile declined from .66 to .55 acres. The amount of land planted to grain increased in every region except North America and Western Europe where it declined 4 and 5 percent respectively. On a per capita basis it declined in every region, with the developed regions now having the better part of an acre per capita as compared with less than half an acre in the less developed regions. The Communist Bloc retained its slight edge over the Free World in planted area per capita throughout the period.

Yields, too, followed divergent trends. Average yields for the world rose 28 percent or just over 1 percent per year over the quarter century span. Increases by region for the same period ranged from a scarcely perceptible 7 percent in Asia to 109 in North America. A close relationship seems to exist between average income per person and the capacity to increase yields.

Chapter VI.--WORLD TRADE IN FOOD

The World Agricultural Trade Pattern

World trade in farm products, measured in terms of exports, amounted to about 25 billion dollars in 1960 or approximately one-fourth of total trade in all commodities (table 22). The largest single group of agricultural commodities entering world trade were the fibers, accounting for 18.1 percent of the total agricultural trade. Principal among these were cotton (a vegetable fiber) and wool (an animal fiber). Following closely after fibers were grains, both food grains and feed grains, accounting for 17.3 percent of the total. Wheat is easily the most important grain, accounting for more than half of the grain total.

The beverage crops--coffee, tea, and cocoa--represent another important commodity group. Coffee, one of the most important commodities entering into world commerce, accounts for almost two-thirds of the 3 billion dollar beverage group total.

Meat and live animals, accounting for 9.7 percent of agricultural trade, represent the next most important category. Beef is easily the largest item in this group. Vegetable oils and oilseeds, a group including both edible and inedible items, accounted for 7.7 percent of agricultural trade in 1960. Soybeans and soybean oil dominate this group, with peanuts, copra, and cottonseed accounting for much of the remainder.

Table 22.--Composition of world agricultural trade, 1960[1]

Commodity group	Value of exports	Share of total	Commodity group	Value of exports	Share of total
	Million dollars	Percent		Million dollars	Percent
Fibers	4,566	18.1	Fruit	1,179	4.7
Grains	4,350	17.3	Dairy products	1,175	4.7
Beverage crops	3,026	12.0	Tobacco	995	3.9
Meat & live animals	2,434	9.7	Wine	511	2.0
Vegetable oils & seeds	1,951	7.7	Other principal commodities	1,585	6.3
Natural rubber	1,801	7.1			
Sugar	1,648	6.5	Total	25,220	100.0

[1] Does not include forestry and fishery products or semi-processed materials sometimes classified as agricultural.

Source: FAO Trade Yearbook, 1961 (16).

Natural rubber, an industrial crop grown in the tropics but marketed almost entirely in the temperate zone, ranks after vegetable oils in value. Its share of the total is likely to decline slowly as synthetic rubber becomes increasingly competitive. Sugar, another crop produced largely in the tropics, accounts for 6.5 percent of world agricultural trade.

Additional items are fruit and dairy products--each accounting for 4.7 percent of agricultural trade--tobacco 3.9 percent, wine 2.0 percent, and all other agricultural commodities 6.3 percent.

For the purposes of this study we are concerned largely with the leading food commodities that enter into trade, mainly grains, meat, edible vegetable oils, sugar, fruit and dairy products. These items comprise about half of world agricultural trade on a value basis. Nonfood crops account for about 40 percent of all trade in crops but they account for less than 7 percent of the total crop area. From this it may be concluded that the share of output of nonfood crops entering into trade is much greater than that of food crops or that the value of output per acre is much higher. Rubber, for example, occupies less than one-half of 1 percent of world cropland area but it represents 7.1 percent of agricultural trade. Coffee accounts for a share of world trade comparable with that of rubber but it too occupies only about half of 1 percent of the harvested crop area.

When the food trade pattern is considered alone, grains completely dominate. Wheat and rice, the two most important grains traded, are used almost exclusively for food.

A Quarter Century of Grain Trade Trends

Wheat

Wheat provides man with one-fifth of all calories consumed and it occupies 22 percent of the world's crop land. It is easily the most widely traded food. In 1960/61 it accounted for nearly 60 percent of world trade tonnage of all grains including both feed and food grains. Between 1934-38 and 1960/61 the tonnage of wheat moving into the world market more than doubled.

During the 1934-38 period, North America, supplying over 5 million metric tons on a net basis, was the leading source of wheat in the world market (table 23). All regions, except Europe and Asia, were net exporters of wheat. With time, Africa and Latin America moved to the deficit side of the ledger and became net importers. As of 1960/61 each importing region was taking at least two million tons annually.

Table 23.--World wheat trade: Total and net trade, by regions, average 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61[1]

Period and Region	Total trade		Net trade	
	Exports	Imports	Exports	Imports
	1,000 metric tons			
Average, 1934-38				
North America	6,030	772	5,258	--
Latin America	3,445	1,668	1,777	--
Western Europe	1,262	11,892	--	10,630
E. Europe & USSR	2,233	120	2,113	--
Africa	535	430	105	--
Asia	1,030	1,900	--	870
Oceania	2,787	60	2,727	--
Average, 1948-52				
North America	18,525	526	17,999	--
Latin America	2,000	2,849	--	849
Western Europe	719	14,036	--	13,317
E. Europe & USSR	NA	NA	NA	--
Africa	353	1,502	--	1,149
Asia	334	5,455	--	5,121
Oceania	3,137	216	2,921	--
Average, 1957/58-59/60				
North America	20,383	252	20,131	--
Latin America	2,493	3,692	--	1,199
Western Europe	3,739	11,479	--	7,740
E. Europe & USSR[2]	5,262	5,439	--	177
Africa	215	2,643	--	2,428
Asia	443	10,090	--	9,647
Oceania	2,298	303	1,995	--
Annual 1960/61				
North America	27,331	221	27,110	--
Latin America	1,915	4,165	--	2,250
Western Europe	2,869	13,727	--	10,858
E. Europe & USSR[3]	5,965	5,219	746	--
Africa	130	3,100	--	2,970
Asia	185	14,410	--	14,225
Oceania	5,055	250	4,805	--

[1] Wheat flour included as wheat equivalent.
[2] 1957-59 Average. FAO Trade Yearbook. Vol. 15. 1961.
[3] Annual 1960. FAO Trade Yearbook. Vol. 15. 1961.

Source: 1934-38 data - FAO Trade Yearbook 1958; 1948-52 data - FAO Trade Yearbook 1960; 1957/58-59/60 and 1960/61 data - FAO, World Grain Trade Statistics, 1960/61.

The world wheat trade pattern of 1934-38 could best be described as one with sources of net regional surpluses well distributed throughout the world but with the market limited almost entirely to Western Europe except for a small fraction going to Asia. In 1960/61 the pattern was reversed with the regions of sizeable net surplus being limited to North America and Oceania and a small surplus in E. Europe and USSR, all other regions being deficit. North America had a large net surplus--27 million metric tons. Oceania had a net surplus of 5 million tons, an amount equivalent in size to the net surplus of North America in the 1930's (fig. 20).

A world inter-regional wheat flow chart would show lines radiating from North America in all directions. Principal flows

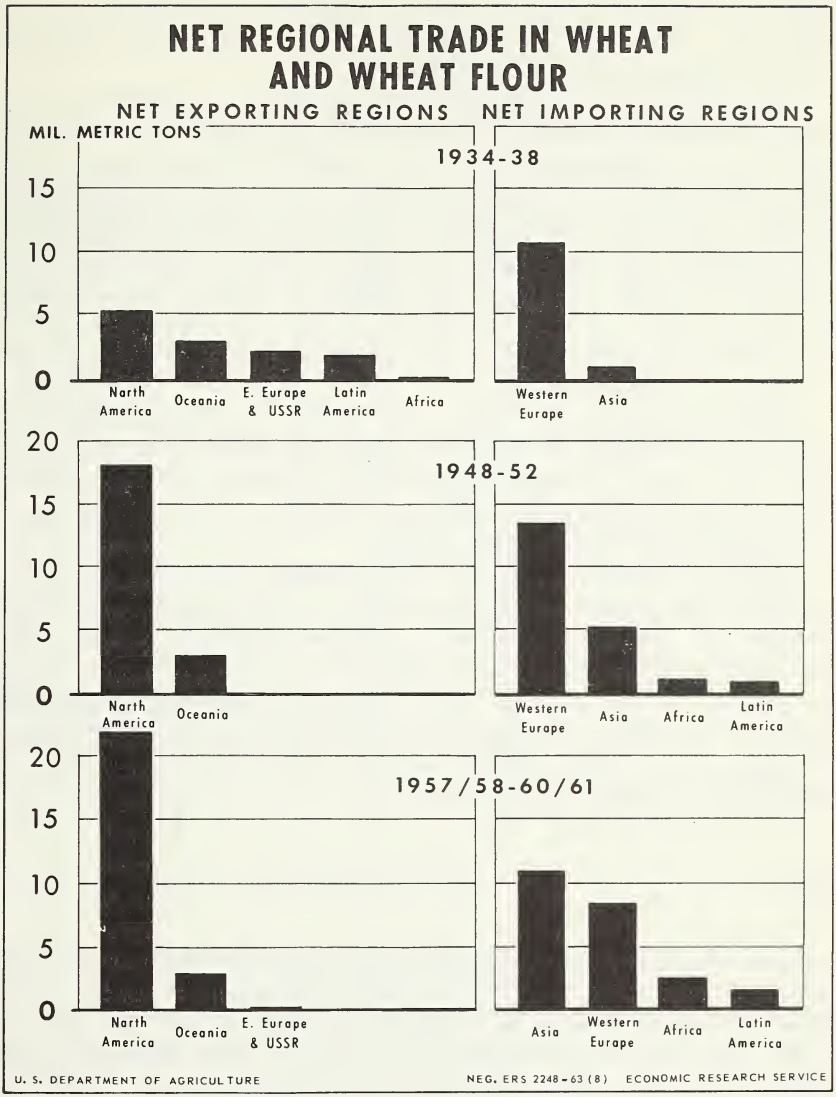

Figure 20

would be to Western Europe and Asia but Africa and Latin America are also taking large tonnages.

Latin America, having average net exports of nearly 2 million tons annually from 1934 to 1938, was importing on a net basis, just over 2 million tons in 1960/61. This region, which had been exporting wheat at a rate of 15 kilograms per capita in the 1930's, had, in the space of a quarter century, become a net importer,

importing 11 kilograms per capita in 1960/61. Clearly, demand had grown far more rapidly than output. If, or when, these divergent trends can be reversed remains to be seen.

The Soviet Bloc, comprised of the Soviet Union and its East European satellites, was, in the 1934-38 period, like Latin America, exporting 2 million tons of wheat annually on a net basis. In the late 1950's however, the Soviet Bloc was on the average deficit, through regaining a slight surplus in 1960/61. The principal difference between the two regions is that whereas Latin America has less than one-half acre per capita planted to grain, the Soviet Bloc is well endowed, having more than one acre per capita--an amount comparing favorably with North America and Oceania, the two surplus producing regions.

Western Europe and Asia are similar in that both were net importers throughout the period under survey but here the similarity ends. The level of wheat imports into Western Europe has been remarkably consistent throughout, indicating a rather stable relationship between demand and output.

In Asia, however, the picture has been quite different, for the net imports were small during the prewar period amounting to only a fraction of Western Europe's. As the population growth rate accelerated after World War II, going from a decade growth rate of 12 percent in the thirties to 17 percent in the forties and even higher in the fifties, the gap between consumption and output began to widen. By the late 1950's Asia had easily displaced Europe as the leading net importer of wheat.

Rice

Over 90 percent of the world's rice supply is produced and consumed in Asia. Unlike wheat, the other principal food staple, rice output and consumption is rather localized. Rice trade is confined largely to Asia, the world's principal surplus and deficit countries being within the region. The net regional surplus, some 2 million tons per year prewar, now averages less than 1 million tons yearly and appears to be dwindling rapidly (table 24).

While the volume of world trade in other major grains such as wheat and corn has made impressive gains over the past quarter century, trade in rice has declined, with 1960 export tonnage amounting to less than two-thirds of prewar. This divergent trend is ostensibly due to the reduction of surpluses in Asian export producing countries. The traditional grain-importing countries of Asia have been obliged to substitute wheat imports for rice imports and increase domestic wheat production as their deficit has rapidly

Table 24.--World rice trade: Total and net trade, by regions, average 1934-38, 1948-52, 1957-59 and annual 1960

Region	Total trade		Net trade	
	Exports	Imports	Exports	Imports
	1,000 metric tons			
Average, 1934-38				
North America	72	108	--	36
Latin America	108	342	--	234
Western Europe	360	1,294	--	934
E. Europe & USSR	12	197	--	185
Africa	120	400	--	280
Asia	8,990	6,910	2,080	--
Oceania	13	40	--	27
Average, 1948-52				
North America	540	37	503	--
Latin America	251	363	--	112
Western Europe	233	382	--	149
E. Europe & USSR	NA	NA	NA	--
Africa	266	183	83	--
Asia	3,252	3,303	--	51
Oceania	29	22	7	--
Average, 1957-59				
North America	693	41	652	--
Latin America	144	360	--	216
Western Europe	301	511	--	210
E. Europe & USSR	183	833	--	650
Africa	296	476	--	180
Asia	4,873	3,988	885	--
Oceania	46	38	8	--
Annual 1960				
North America	998	66	932	--
Latin America	131	181	--	50
Western Europe	247	592	--	345
E. Europe & USSR	22	967	--	945
Africa	344	518	--	174
Asia	5,137	4,167	970	--
Oceania	73	39	34	--

Source: 1934-38 data - FAO Trade Yearbook 1958; 1948-52 and 1957-59 data - FAO Trade Yearbook, 1960; 1960 data - FAO Trade Yearbook, 1961.

increased. Another factor contributing to the trend is the fact that wheat can be imported at a much lower price than rice. This trend is likely to continue and it does not seem likely that the region will long retain its dwindling net surplus of rice.

The rice trade pattern has changed considerably in 25 years. During the prewar period, Asia was the only net exporter and all other regions were net importers. North America, however, became a net exporter after World War II, gradually expanding its exports until in 1960 it reached nearly a million tons. It now appears quite likely that the net export surplus for North America will easily exceed that of Asia for 1962.

The extremely marginal nature of rice trade is indicated by per capita trade figures. Net rice exports in Asia amounted to 2 kilograms per capita per year before World War II but since the war they have declined reaching a low of .6 kilograms in 1960. North

American net rice exports, at 5 kilograms per person in 1960, are quite small compared to the other major grains.

Although rice is a major grain in production terms, along with wheat and corn, the amount entering into world trade channels more nearly compares with minor grains such as barley, rye, or millet and sorghum. Rice is produced largely in subsistence economies and individual producers are characterized by a limited surplus producing capacity. Export surpluses in Asia are generated by a large number of producers having small surpluses rather than a relatively limited number of commercial producers having large surpluses.

Corn

Chief among the distinguishing characteristics of world corn trade during the quarter century under survey, has been the relatively stable level of exports. Both total and net regional exports were slightly larger in 1960/61 than prewar and appear to be headed upward (table 25). The import pattern remained essentially the same with Western Europe continuing as the only large net importer. Asia, a net exporter of modest tonnages of corn before the war is now a small but steadily growing net importer. In direct contrast to the import pattern, the regional export pattern changed drastically from prewar to 1960/61. Latin America, supplying the bulk of world corn exports in 1934-38, gradually relinquished its position and by 1960/61 North America had easily become the leading regional exporter. Both regions increased corn output, but North America at a much faster rate. The relatively slow rate of increase in Latin America's production combined with its unprecedented population growth rate, rapidly reduced export availabilities. As population growth outstripped the 28-percent expansion in corn production, per capita output declined from 147 to 112 kilograms per year. Per capita output in North America meanwhile went from 375 to 561 kilograms.

Corn is widely used as both a feed grain and a food grain. In North America, where just over half of the world's supply is produced, it is used largely for livestock feed. In other regions of production, especially Latin America and Africa, it is principally a food grain. It is an important source of calories in nearly all Latin American countries. Only in a few countries, such as Argentina and Uruguay, is it produced principally for livestock feed.

A rather unique relationship exists between the mode of utilization and exports. Nearly all corn entering into world trade, mostly destined for Western Europe and Japan, is used for livestock

Table 25.--World corn trade: Total and net trade by regions, averages 1934-38, 1948-52; 1957/58-59/60 and 1960/61

Region	Total trade		Net trade	
	Exports	Imports	Exports	Imports
	1,000 metric tons			
Average, 1934-38				
North America	800	1,140	--	340
Latin America	6,610	23	6,587	--
Western Europe	133	8,459	--	8,326
E. Europe & USSR	1,197	224	972	--
Africa	670	40	630	--
Asia	770	230	540	--
Oceania	2	2	--	--
Average, 1948-52				
North America	2,306	222	2,084	--
Latin America	1,200	60	1,140	--
Western Europe	51	3,999	--	3,948
E. Europe & USSR	NA	NA	NA	--
Africa	373	278	95	--
Asia	162	213	--	51
Oceania	18	--	18	--
Average, 1957/58-59/60				
North America	5,054	318	4,736	--
Latin America	2,168	630	1,538	--
Western Europe	74	7,061	--	6,987
E. Europe & USSR[1]	731	409	322	--
Africa	1,197	120	1,077	--
Asia	350	1,050	--	700
Oceania	--	--	--	--
Annual 1960/61				
North America	6,610	499	6,111	--
Latin America	1,965	380	1,585	--
Western Europe	695	8,954	--	8,259
E. Europe & USSR[2]	1,100	620	480	--
Africa	1,130	190	940	--
Asia	730	2,160	--	1,430
Oceania	--	--	--	--

[1] 1957-59 average. FAO Trade Yearbook, Vol. 15. 1961.
[2] Annual 1960. FAO Trade Yearbook, Vol. 15. 1961

Source: 1934-38 data - FAO Trade Yearbook, 1958; 1948-52 data - FAO Trade Yearbook 1960; 1957/58-59/60 and 1960/61 data - World Grain Trade Statistics, 1960/61.

feed. That sizeable share of corn output produced for domestic consumption outside North America, however, is utilized largely as food, being considered a staple or substaple in many countries. Asia's imports go almost entirely to Japan where it is used as a feed grain to support the rapidly expanding livestock industry.

Other grains

Grains may be arbitrarily divided into two groups, major grains and minor grains, on the basis of their importance in production and trade. Rice, wheat, and corn may be considered major grains--together they accounted for almost three-fourths of world production

and over four-fifths of world trade in 1960/61. The four remaining grains, barley, sorghum and millets, rye, and oats are minor grains and they are treated collectively in this section. (See tables A6-A9 for trade data.)

Output of two minor grains, oats and rye, has declined steadily over the past quarter century. Associated with this drop in output, ranging from 10 to 20 percent, has been a rather static level of trade. Annual world exports of each of the two grains has consistently ranged around a million tons. The remaining minor grains, barley and millets and sorghum, have followed quite different trends, as both production and trade have expanded. Production gains of barley and millets and sorghum, amounting to 60 and 40 percent respectively on a world basis was concentrated in surplus producing regions thus setting the stage for expanded trade. Barley exports almost doubled between 1934-38 and 1960/61 while millet and sorghum exports increased some 4 fold.

Certain general observations can be noted for each of the four grains. Western Europe was the major net importer of each grain before World War II and it has continued in this position until the present. Also of interest is the fact that North America, which, during the prewar period, was not the leading exporter of any of these minor grains, and in fact was a net importer of rye and millets and sorghum, is now the leading net regional exporter of each of the four grains.[5]

The millet and sorghum trade pattern has evolved into essentially a one way flow between North America and Western Europe where it is used as a feed grain to bolster the growing livestock industry. In 1960/61 North America, with net exports of 2.2 million metric tons, accounted for 88 percent of net regional exports and Western Europe, with just under 2 million tons, 84 percent of net regional imports. This one way flow between the two regions mentioned above is to some extent characteristic of each of the minor-grain trade patterns as of 1960/61.

Total grains

The world trade grain pattern of 1960/61 bears little resemblance to that of 1934-38 (fig. 21). In 1934-38, six of the seven geographic regions were net grain exporters; in 1960/61 only three of the seven were net exporters, the remaining three having made the transition

[5] It should be noted here that 2 of the 5 years comprising the 5-year average were years of extensive drought thus reducing the export tonnages somewhat below normal.

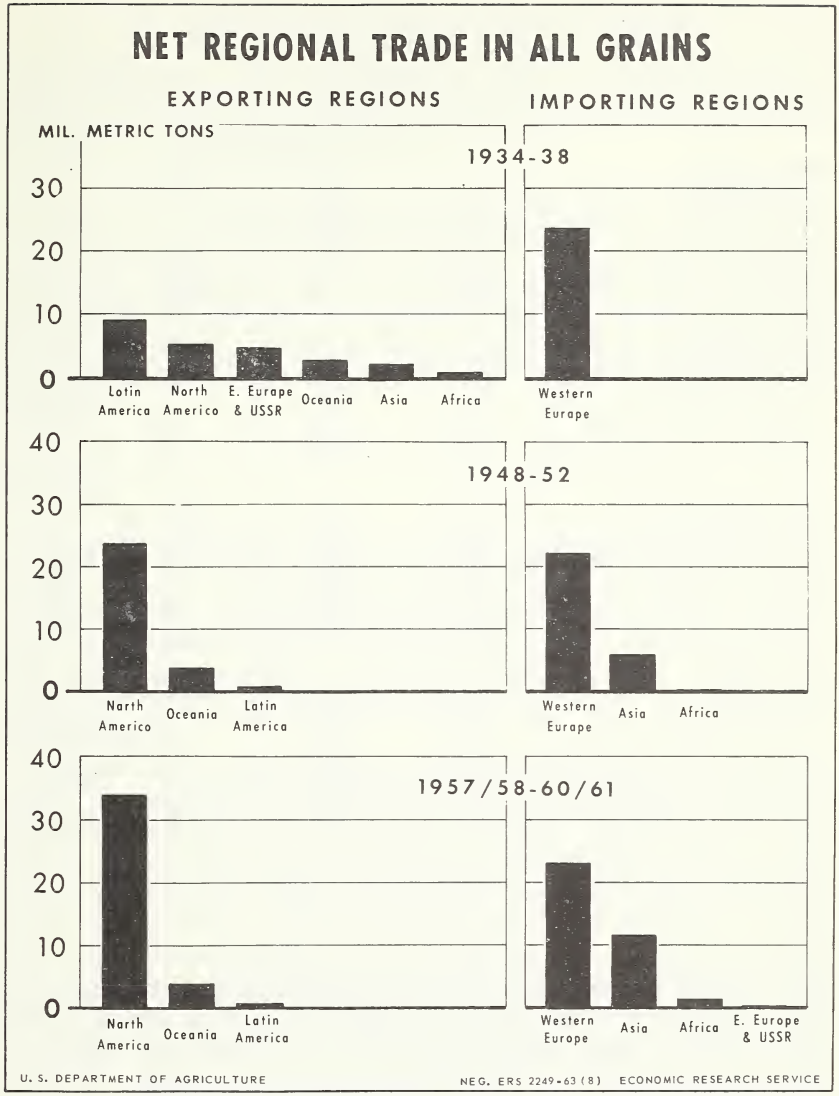

Figure 21

from net surplus to net deficit (table 26). Latin America, the region with the largest net surplus prewar became a deficit region in 1960/61.

North America, accounted for 22 percent of net regional exports prewar but by 1960/61 this percentage had risen to 86 percent. Oceania accounted for 13 of the remaining 14 percent. In achieving this dominant position as a supplier in the world market,

Table 26.--World grain trade: Total and net trade in all grains, by regions, average 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61

Region	Total trade		Net trade	
	Exports	Imports	Exports	Imports
	1,000 metric tons			
Average, 1934-38				
North America[1]	7,674	2,362	5,312	--
Latin America	11,147	2,068	9,079	--
Western Europe	2,047	25,788	--	23,741
E. Europe & USSR	5,284	618	4,666	--
Africa	1,671	1,001	670	--
Asia	11,657	9,470	2,187	--
Oceania	2,881	113	2,768	--
Average, 1948-52				
North America	25,052	1,667	23,385	--
Latin America	4,161	3,319	842	--
Western Europe	1,406	23,431	--	22,025
E. Europe & USSR	NA	NA	--	--
Africa	1,695	2,025	--	330
Asia	4,432	10,327	--	5,895
Oceania	3,686	240	3,446	--
Average, 1957/58-59/60				
North America	32,809	1,196	31,613	--
Latin America	5,919	4,842	1,077	--
Western Europe	5,336	27,750	--	22,414
E. Europe & USSR	7,576	8,016	--	440
Africa	2,100	3,326	--	1,226
Asia	6,193	16,323	--	10,130
Oceania	3,146	341	2,805	--
Annual 1960/61				
North America	40,501	1,134	39,367	--
Latin America	4,726	4,966	--	240
Western Europe	5,723	31,038	--	25,315
E. Europe & USSR	8,267	7,881	386	--
Africa	1,974	4,128	--	2,154
Asia	6,157	22,182	--	16,025
Oceania	6,243	289	5,954	--

[1] See footnote 5, p.68.

Source: This table summarizes all individual grain tables

North American per capita grain exports had risen from 37 to 200 kilograms per year. The regions net grain exports of 39.4 million metric tons in 1960/61 greatly exceeded total annual net regional exports of all six exporting regions in 1934-38.

Of all the regions, only Western Europe maintained a stable position in the world grain market. Its net grain imports have not varied more than 10 percent during the four periods for which data has been compiled. North America, raising its net exports by 34 million tons experienced the greatest change during the 24 year period. Asia was next with a net change of 18.2 million tons. Latin America followed with a net change of 9.3 million tons. Undergoing the least pronounced changes were Eastern Europe and the Soviet Union, Oceania and Africa.

By 1960/61 North America had achieved the unique distinction of being the principal supplier of every one of the seven grains except rice where Asia maintained a slight though fast disappearing lead. Western Europe enjoyed a comparable position with respect to imports of every grain except rice.

Other Selected Foodstuffs

The two commodities selected for discussion here are not chosen necessarily because of their dominant position in world food trade but because they are likely to play an important role in eliminating the fat and animal protein deficits prevalent in the less developed regions.

Soybeans

Some 27 countries, all in the three underdeveloped regions of Asia, Africa, and Latin America, had national diets deficient in fat in 1958. Soybeans produced in North America may prove to be the most satisfactory means of reducing this nutritional inadequacy in some of these countries. Consumed whole, soybeans serve a dual need for in addition to providing fat they are a source of much needed pulse protein.

Soybeans are native to China and only in recent decades have they attained a position of importance in U.S. agriculture. During the 1934-38 period Asia, mostly China, completely dominated the world market, supplying 98 percent of net regional exports (table 27). After World War II, Asia lost its export advantage and even though China has exported widely varying, and often sizeable, amounts since then, the quantities have not usually been sufficient to offset net deficits developing in other Asian countries, particularly Japan.

During and after the second World War soybean output in North America, almost entirely in the United States, expanded even faster than the rapidly growing domestic demand for soybeans. This created a strong soybean export potential. During the 1948-52 period North America was the only region with a net surplus, exporting 1.2 million metric tons. Net exports continued to climb sharply, reaching an average of 4.4 million tons in 1957-59 and 5.1 million in 1961. During these three postwar periods on which data has been tabulated, North America has been the only net exporter of soybeans. Each of the other six geographic regions including Asia has been a net importer during these periods.

The regional export pattern has changed radically. Asia was initially the only surplus area, but since World War II North

Table 27.--World soybean trade: Total and net trade, by regions, average 1934-38, 1948-52, 1957-59 and annual 1961[1]

Region	Total trade		Net trade	
	Exports	Imports	Exports	Imports
	1,000 metric tons			
Average, 1934-38				
North America	65	37	28	--
Latin America	--	39	--	39
Western Europe	266	1,727	--	1,461
E. Europe & USSR	5	48	--	43
Africa	--	49	--	49
Asia	2,655	877	1,778	--
Oceania	--	--	--	--
Average, 1948-52				
North America	1,325	123	1,202	--
Latin America	22	42	--	20
Western Europe	55	1,056	--	1,001
E. Europe & USSR	3	19	--	16
Africa	3	24	--	21
Asia	129	323	--	194
Oceania	--	--	--	--
Average, 1957-59				
North America	4,830	385	4,445	--
Latin America	31	189	--	158
Western Europe	302	3,120	--	2,818
E. Europe & USSR	16	874	--	858
Africa	13	144	--	131
Asia	1,250	1,387	--	137
Oceania	--	5	--	5
Annual 1960				
North America	6,751	503	6,248	--
Latin America	--	253	--	253
Western Europe	566	4,546	--	3,980
E. Europe & USSR	31	734[2]	--	703
Africa	5	369	--	364
Asia	1,164	1,875	--	711
Oceania	--	16	--	16

[1] Include soybean equivalent of soybean oil.
[2] USSR data not available for soybean oil.

Source: 1934-38 and 1948-52 data - FAO Trade Yearbook 1958; 1957-59 data - FAO Trade Yearbook, 1962; 1960 data - FAO Trade Yearbook 1961.

America has had the only net surplus. The net import pattern by region has been much more stable, as Western Europe has dominated the import scene consistently both prewar and postwar. In the late 1950's and early 1960's, however, it began to lose its total dominance, as Asia developed a net deficit in excess of one million tons. Western Europe's share of net regional imports declined from 92 percent prewar to 66 percent in 1960.

Dry milk

Trade in dry milk is largely a postwar development since only negligible quantities were entering world trade before the War.

This commodity is included not necessarily because of its importance in world food trade but because it is the commodity likely to play a major role in eliminating animal protein deficits in several less developed countries mostly in Asia.

Powdered milk is not the only source of animal protein which could serve to alleviate shortages but it is for many reasons the most practical. It is among the least costly; it stores well in powder form without refrigeration even in warm humid areas; it is concentrated and therefore is readily transported and distributed; it is everywhere acceptable as a food whereas many forms of animal protein are not acceptable in countries such as India. Prior to the development of the powdered milk process, international trade in dairy products had been limited largely to milk products such as cheese and butter.

As in the case of grains, North America and Oceania have dominated the export scene (table 28). Although Western Europe

Table 28.--World powdered milk trade: Total and net trade, by regions, average 1934-38, 1948-52, 1957-59 and annual 1960

Region	Total trade		Net trade	
	Exports	Imports	Exports	Imports
	1,000 metric tons			
Average, 1934-38				
North America	4	3	1	--
Latin America	1	1	--	--
Western Europe	18	17	1	--
E. Europe & USSR[1]	--	--	--	--
Africa	--	1	--	1
Asia	--	4	--	4
Oceania	9	--	9	--
Average, 1948-52				
North America	145	7	138	--
Latin America	--	45	--	45
Western Europe	50	30	--	30
E. Europe & USSR[1]	--	1	--	1
Africa	--	4	--	4
Asia	2	51	--	49
Oceania	48	--	48	--
Average, 1957-59				
North America	351	3	348	--
Latin America	1	98	--	97
Western Europe	127	181	--	54
E. Europe & USSR	--	2	--	2
Africa	--	17	--	17
Asia	1	125	--	124
Oceania	90	1	89	--
Annual 1960				
North America	253	2	251	--
Latin America	--	99	--	99
Western Europe	166	170	--	4
E. Europe & USSR	3	1	2	--
Africa	--	20	--	20
Asia	1	121	--	120
Oceania	85	1	84	--

[1] Figures pertain to Eastern Europe only, since data are not available for the USSR during this period.

Source: 1934-38 data - FAO Trade Yearbook 1958; 1948-52, 1957-59 and 1960 data - FAO Trade Yearbook, 1961.

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exports large quantities of powdered milk it also imports large quantities and on balance, has usually been a net importer. North America has consistently accounted for about three-fourths of total net regional exports, the remaining one-fourth being supplied by Oceania.

The regional pattern of net trade in powdered milk has remained quite stable throughout the postwar period. The import pattern, however, has been much less consistent. Asia has been the leading net importer in each of the three periods for which data has been compiled. Its share of net regional imports has, however, expanded from about one-third in 1948-52 to one-half in 1960.

Chapter VII.--REGIONAL TRENDS IN NET GRAIN TRADE

Geographic Regions

Asia: Surplus to Deficit

Asia is unique among the seven geographic regions in that it has both a high rate of population growth and an already dense population. Asia's percentage of population increase--44 percent during the 25-year span under survey--was significantly overshadowed only by Latin America. In terms of area in grain it has only .42 acres per capita, less than any other region except Western Europe. These two factors make it increasingly difficult for Asia to raise or even to maintain per capita food production levels.

Just prior to World War II Asia was producing a net grain surplus of 2.2 million metric tons or 2 kilograms per capita (table 29 and fig. 22). By 1948-52, however, the region had become a net importer of grain to the extent of 5.9 million tons per year. The deficit continued to grow during the 1950's and net imports reached an unprecedented 16.2 million tons in 1960/61.[6]

Table 29.--Net grain trade by geographic regions, average 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61[1]

Region	1934-38	1948-52	1957/58-59/60	1960/61
	- - - - - - - - -Million metric tons- - - - - - - - -			
North America	-5.3	-23.4	-31.6	-39.4
Latin America	-9.1	-.8	-1.1	+.2
Western Europe	+23.7	+22.0	+22.4	+25.3
E. Europe & USSR	-4.7	n.a.	+.4	-.4
Africa	-.7	+.3	+1.2	+2.2
Asia	-2.2	+5.9	+10.1	+16.0
Oceania	-2.8	-3.4	-2.8	-6.0

[1] Includes all grains. Minus = net exports; Plus = net imports.

Source: Earlier trade tables on individual grains.

[6]The term "deficit" here refers to the economic deficit, i.e., the excess of imports over exports. It should not be confused with the nutritional deficit as defined in Chapter IV.

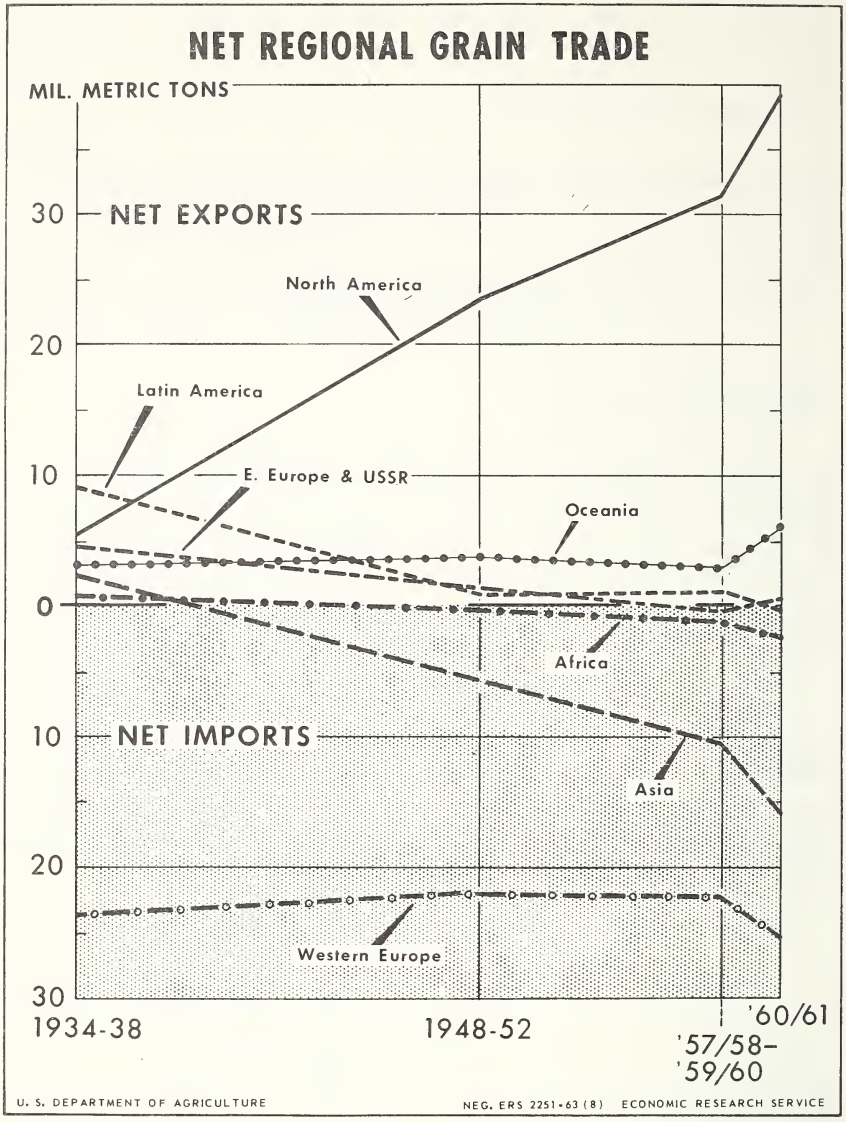

Figure 22

Perhaps the most significant aspect of this development is not simply the fact that Asia made the transition from surplus to deficit but the abruptness with which this occurred and the rapidity with which the deficit has grown. Something like half of net regional imports in 1960/61 were required to offset decline in per capita output while the remainder permitted a slight improvement in diets. Although the per capita output of 226 kilograms in 1960/61 was lower

than the 231 kilogram annual average during the 1934-38 period, per capita availability has risen from 229 to 236 kilograms (See tables A13 and A14). Without the transition from net exporter to net importer this modest improvement would not have occurred.

Asia is now beginning to rival Western Europe as a net importing region. In terms of food grains alone Asia has displaced Western Europe as the leading net regional importer. Western Europe's imports of feed grains are large, however, thus giving it a substantially greater net import volume for all grains.

Certain aspects of this situation are of interest. First, Western Europe has been a consistent large net importer of grains for many decades while Asia has emerged, by comparison, only quite recently. Secondly, Western Europe's net imports are rather evenly divided between food grains and feed grains, while Asia's are limited mostly to food grains, mainly wheat. Europeans are interested in animal products whereas in Asia calories are still of prime importance. Thirdly, Europe's imports are made through commercial channels whereas Asia's are possible largely as a result of concessional government-to-government sales agreements.

Africa: Surplus to Deficit

Africa, alone among the three less developed geographic regions, has been able to raise per capita grain output over the past quarter century. Even so, it, like Asia and Latin America has made the transition from grain surplus to deficit. The shift from net exporter to net importer has occurred in response to a rise in per capita food demands rather than as an offset to declining per capita output.

Africa has had some advantages over the other two regions. It has more land per capita available for grain production and its rate of population growth has been much less than Latin America's although not significantly less than that of Asia.

The African economy has never been closely integrated into the world economy and its role in world grain trade has been relatively minor. In contrast with each of the other six geographic regions, Africa has never been either a large exporter or importer of grains. Current net grain imports of over 2 million tons represent an all-time high.

In terms of per capita surplus or deficit, the trend in Africa has paralleled that of Asia. Prior to the war Africa was exporting on a net basis at the rate of 4 kilograms per capita annually. Net grain imports began during the immediate post war period and by 1960/61 imports amounted to 9 kilograms per capita.

In summary, Africa's grain output has more than kept pace with population growth but it has not gained sufficiently to satisfy the combined effect of population increase and rising per capita income. Per capita consumption has risen from 154 kilograms per year to 179. Of this increase, rising domestic production has provided for 12 kilograms per person while the shift to being a net importer has made possible the remaining 13-kilogram improvement in per capita consumption.

Latin America: Surplus to Deficit

No other geographic region has experienced a deterioration in its standing in world grain trade comparable to that of Latin America. During the late 1930's the region dominated the world grain market as a supplier. It exported more grain than North America and Oceania combined; it was an important supplier of wheat and its net corn exports accounted for almost three-fourths of those of all regions. By 1960/61 Latin America had relinquished its impressive advantage and, in spite of its vast natural resources, emerged as a net deficit region.

A not inconsiderable effort was made in Latin America, especially during the 1950's, to raise output by expanding the area used for grain production. This effort resulted in an expansion of the grain producing area by nearly one-third over that of the prewar period, but population increased two-thirds and efforts to push up yields met with little success.

Total production gains of some 42 percent during the period did not compare unfavorably with many other regions but population grew 66 percent, much more than in any other region. Latin America's population was growing at a rate easily in excess of 20 percent per decade from 1930 to 1960. This stage of rapid population growth, with all its attendant problems is only now being approached in Africa and Asia.

In spite of the decline in per capita grain production from 254 kilograms in 1934-38 to 214 in 1960/61, availability has risen from 180 to 216 kilograms per person. This has been achieved by sacrificing net exports, which amounted to 74 kilograms per person in 1934-38, and becoming a net importer to the extent of 2 kilograms per person in 1960/61. Of this 76-kilogram change in the per capita trade position, 40 kilograms were required to offset the decline in output per person. The remaining 36 kilograms represent an improvement in per capita consumption. Thus while per capita output was declining 16 percent, per capita consumption was rising 20 percent, but at the expense of exports and the foreign exchange so vitally needed for industrialization.

Eastern Europe and the USSR: Surplus to Deficit

Three of the world's geographic regions have more than one acre of grain producing land per capita. One of these is Eastern Europe and the Soviet Union. The other two, North America and Oceania, have capitalized on this valuable asset by producing large net surpluses of grain for the world market. The Soviet Bloc, a leading supplier of grain in the world market prior to World War II, has not been able to exploit this valuable asset and in spite of its abundant land resources, emerged as a net importer of grain in the late 1950's. In 1960/61 the Soviet Bloc did manage to arrest the long term trend, at least temporarily, by producing a small net surplus. Many factors may account for this long term trend, but principal among these seems to be the Communist genius for organizing agriculture in such a fashion as to sever the link between effort and reward, thus destroying initiative.

It is interesting to note that total grain output, increasing only 24 percent in as many years, increased less than in any other region, developed or underdeveloped. Population in the Bloc countries grew very slowly, however, during the quarter century span under survey. Total growth for the period amounted to 18 percent, slightly more than Western Europe, but only a fraction of that in all other regions. It was thus possible to realize a gain in per capita grain production as output went from 533 kilograms in the late 1930's to 558 in 1960/61. Consumption meanwhile, went from 517 to 557 kilograms. This was made possible by the gain in per capita output of 25 kilograms and the sacrifice of the export advantage of 15 kilograms per person in the late 1930's.

Recent years have witnessed major efforts by the Soviet Union and its satellites to expand the area planted to grain. This appears to have met with only limited success, for 80 percent of the additional output has resulted from higher yields. The area planted to grains in fact reached a peak in the late 1950's and then declined in 1960/61 by 2 percent. The Soviet Bloc has, when closely analyzed, many economic characteristics of the less developed regions especially with regard to consumption patterns and the volume of trade. One of these characteristics is in evidence here--the Soviet Bloc, unlike the other land-abundant developed regions of North America and Oceania, has lost the substantial grain export surplus it enjoyed throughout the earlier decades of this century.

Western Europe: Consistent net importer

Western Europe, long noted for its demographic stability, has maintained a remarkably constant position in a world grain trade

pattern generally characterized by major regional shifts and reversals. The region is unique in that gains in per capita consumption have been compensated for by gains in per capita production. Annual per capita output rose 46 kilograms, from 247 kilograms in 1934-38 to 293 in 1960-61; consumption rose by 42 kilograms, going from 335 to 377 kilograms. Net per capita grain imports, varying slightly during the period were about the same at the beginning and end of the period.

Western Europe was the only geographic region with a net deficit in grain during the 1934-38 period; each of the other six regions had a net surplus. (See footnote 6, p. 75.) It was also the principal net importer of each grain considered individually during the late thirties. It still maintains this distinction in 1960/61 for each grain except wheat. In the late 1950's, Asia, with its rapidly widening food deficit, displaced Western Europe as the leading net importer of wheat. Figures for 1960/61 showed net imports amounting to 14.2 million tons for Asia as against only 10.9 million metric tons for Europe. Wheat accounts for almost all of Asia's grain imports whereas Western Europe's are rather evenly distributed between wheat and feed grains.

As of 1960/61 Western Europe, once the only net importing region, had been joined by the three less developed regions and it accounted for only 58 percent of net regional imports. One key difference is that while virtually all grain moving into Western Europe is purchased commercially much of that moving into the other regions does so under concessional non-dollar sales agreements from the United States.

Modest population increases of only 11 percent over the past quarter century have made it much easier for the region to increase grain output faster than population. Unlike most regions, however, Western Europe has not been able to expand the cultivated area and additional output has accrued from improvement in yields. Per capita area planted to grain, only .33 acres in 1960/61, was considerably lower than in any other region.

Oceania: A Growing Role

Oceania has traditionally been a net exporter of grain but its importance in the world grain pattern has been enhanced as most regions have developed a net deficit, thus enabling its net exports to pick up sharply during the last few years. Net exports of grain hovered around 3 million tons from prewar until 1960/61 when they climbed abruptly to 6 million tons, or double their customary level. Much of this gain resulted from the large shipments going into

Mainland China as the Communist Government sought food relief to avert possible famine. Grain exports in 1934-38 consisted almost entirely of wheat but in 1960/61 wheat accounted for only 81 percent of net regional exports, barley and oats making up the remainder. This general long-term shift in the composition of exports was quite similar to that experienced in North America.

Per capita grain output in Oceania, exceeded only by North America, gained 233 kilograms, going from 455 in 1934-38 to 688 in 1960/61. Of this per capita gain, 113 kilograms were added to domestic per capita utilization. The remaining 120 kilograms were added to per capita net exports, increasing the total to 372 kilograms per year.

Total grain output in the region expanded 120 percent over the 24 year stretch but most of this gain was concentrated at the end of the period. Two-thirds of the additional output reflected rising yields while the other one-third resulted from expanding the area. The region is well endowed with land available for grain production; the per capita harvested area of 1.3 acres in 1960/61 was slightly greater than that in either North America or the Soviet Bloc.

North America: Emerging Breadbasket of the World

The phenomenal progress in expanding output per person and raising yields in North America over the past 24 years, scarcely conceivable a few decades ago, has set the stage for North America's emergence as the breadbasket of the world. Gains in per capita output over this period, amounting to 339 kilograms per year, far exceed total current output per person in any of the less developed regions.

As of the late thirties, North America was completely overshadowed as a net grain exporter by Latin America and it was only slightly ahead of Eastern Europe and the Soviet Union. (See footnote 5, p. 68.) Oceania and Asia, too, were formidable competitors. By 1960/61, however, North America had become the principal exporter, on a net basis, of all grains considered aggregately and of each grain considered individually, except rice. It accounted for 86 percent of all regional net exports of grain. No region has so completely dominated world grain trade in modern times.

The gain in annual per capita grain output in North America, going from 768 kilograms prewar to 1,107 in 1960/61, amounted to a total of 339 kilograms. About half, or 163 kilograms per person, has been added to net regional exports. The remaining one-half of the per capita output gain is absorbed domestically or goes into stocks.

It should be noted here that direct consumption of grains has been trending downward during this period and that the additional grain is consumed after conversion to livestock products.

Net grain exports of North America for the 1934-38 period, consisted almost entirely of wheat and the region was actually a net importer of corn. Wheat accounted for only two-thirds of net regional grain exports in 1960/61, however, the remaining one-third consisting of other grains, mostly corn.

The Less Developed World

Certain facts are obvious concerning the net grain trade position of the less developed world. Principal among these is the fact that the less developed world is steadily losing the capacity to feed itself.

During the years prior to World War II, all three less developed regions were net exporters of grain. These grain exports earned much of the foreign exchange needed for imports of capital goods. At various times between 1934-38 and 1960/61 each of the geographic regions comprising the underdeveloped world made the transition from surplus to deficit. By 1948-52 the less developed world as a whole had become deficit to the extent of 5.4 million tons. By 1957/58-59/60 net grain imports reached 10.3 million tons, an amount just slightly larger than the net regional exports prewar. This deficit, aided by the deteriorating food situation in Communist China, grew rapidly and in 1960/61 it totaled 18.6 million tons.

The cause of this portentous development seems simple. The less developed regions have not been able to bring new land under cultivation fast enough to keep up with the population; they have not had capital to substitute for land in the production process; and returns on additional labor inputs have long since been diminishing and may, in fact, have reached zero in certain heavily populated countries.

The Communist Bloc

The Soviet Union and countries of Eastern Europe, once the breadbasket of all Europe and therefore the world as well, maintained a sizable net regional surplus until as recently as 1934-38. Since World War II this enviable position has been lost and the Soviet Bloc, in spite of its vast land resources became a grain deficit area in the late 1950's. Communist China, also a large net exporter of grains, mostly rice, during the mid-1950's has now become one of the world's leading grain deficit countries. As of 1960/61, the Communist Bloc was dependent on the Free World for 2.3 million tons of grain.

Chapter VIII.--THE FACTORS OF PRODUCTION

Factor Availability in Agriculture

Availability of each of the three conventional factors of production--land, labor, and capital--varies greatly between geographic regions. The relative quantities of factor inputs or the production mix in agriculture therefore also vary widely between regions. Developed regions are generally characterized by high capital inputs and relatively low labor inputs per unit of land, whereas less developed regions usually have low capital inputs and high labor inputs.

Land--A diminishing per capita supply

Each of the three conventional input factors has its own special characteristic. As an economy develops the share of the labor force in agriculture declines. Capital is not in fixed supply; the amount used in agriculture, relative to the other factors can increase almost indefinitely, providing it is available. Land, however, is in limited supply. This sets it apart from the other inputs.

Except for recent decades, the world's cropland area has historically expanded at a rate approaching the population growth rate. If the trend in the grain area is considered representative of the trend in the total cropland area, the rate of expansion in recent decades has been well under 1 percent per year. World population, meanwhile, is growing at nearly 2 percent per year. Clearly on a worldwide basis, the area of cropland per person is diminishing. It is also diminishing in every one of the seven geographic regions considered individually. In two of the seven regions, North America and Western Europe, the area planted to grains actually declined from 1934-38 to 1960/61.[7] This combined with steady population growth resulted in a pronounced decline on a per capita basis. The per capita grain producing area in North America

[7] The reasons for the decline were, however, different. That in North America reflected largely crop limitations, while the decline in Western Europe was due more to actual pressure of population.

declined from 1.73 to 1.19 acres between prewar and 1960/61. This one-third decline in the area per person was sharper than in any other region.

The area of grain producing land per person averaged 1.02 acres in the developed world and .48 acres in the less developed world for the 1934-38 period. In 1960/61, the corresponding figures were .85 and .43 acres. The per capita decline amounted to 17 and 10 percent respectively in the two major economic regions.

Labor--The abundant factor

Labor always seems to be abundant in agriculture regardless of the stage of development (table 30). Demand for labor in the nonagricultural sectors of agrarian societies is limited. In advanced economies, demand for labor outside agriculture usually seems to lag behind the surplus of farm labor available for transfer.

In underdeveloped societies, the local labor supply is usually more than adequate except possibly during the busy planting and harvesting seasons. The widespread seasonal unemployment common to most agrarian societies contributes much to the low levels of agricultural productivity.

Labor inputs per acre, in many of the more densely populated countries, have reached a level where additional labor inputs

Table 30.--Agricultural population as share of total population, by region, reported 1937 and 1950, estimated 1960

Region	Total population[a]			Agricultural population[b]			Share agri. pop. of total[c]		
	1937	1950	1960	1937	1950	1960	1937	1950	1960
	- - Millions - - - - -			- - Millions - - -			- - Percent - -		
Geographic regions									
North America	143	168	197	33	24	22	23	14	11
Latin America	124	163	206	77	95	113	62	58	55
Western Europe	273	278	300	76	70	69	28	25	23
E. Europe & USSR	290	296	339	160	139	139	55	47	41
Africa	167	199	235	127	131	136	76	66	58
Asia	1,137	1,380	1,620	841	911	972	74	66	60
Oceania	11	13	16	3	3	3	26	22	19
Economic regions									
Developed regions	716	755	852	272	236	233	38	31	27
Less developed regions	1,429	1,742	2,061	1,045	1,137	1,221	73	65	59
Political regions									
Free World	1,395	1,644	1,920	821	870	926	59	53	48
Communist Bloc	748	853	993	496	503	528	66	59	53

Sources: (a) Table 1. (b) Calculated by multiplying total population by agricultural share of population as shown in this table. (c) FAO Production Yearbook. Vol. 15, 1961. Tables 4A and 4B. (15)

would add little to the total product, i.e., the marginal product of labor is close to zero. In many cases higher labor inputs per unit of land could be effectively utilized if more capital inputs such as fertilizer, insecticides, etc., were available.

The acres of farm land per member of the agricultural labor force varies widely, depending on population density and stage of development or share of labor force in agriculture. At one extreme are the densely populated countries like Japan and Taiwan with less than one acre of cropland per farm worker. At the other extreme are countries like the United States, where each agricultural laborer handles an average of 50 acres of cropland.

The amount of capital investment per worker in agriculture can also vary widely. In some countries, such as Bolivia, it may be only several dollars; in others, such as Australia, it may amount to several thousand dollars. Labor productivity in agriculture is of course closely associated with the size of the capital complement per worker.

Capital--a scarce factor

Capital is readily available for investment in agriculture only in a few select areas of the world such as North America, Oceania and Western Europe. Capital is, almost by definition, scarce in the less developed regions. Per capita income is low, averaging between $50 and $100, and rising very slowly in most underdeveloped countries.

Seriously impeding the rise in per capita income are the high rates of population growth. With population growing 2 to 3 percent annually, the economy must expand at least this fast to maintain existing per capita incomes. The U.S. economy has one of the best long-term growth records of any country and yet it has been able to average an annual increase of only 3 percent per year over the past several decades. (28) If the less developed countries cannot exceed this, then gains in per capita income will be meager indeed. Under these circumstances, it is very difficult to accumulate capital for investment in agriculture.

Even after appreciable gains in per capita income are achieved, only the first of a series of obstacles has been overcome. Once made, a part of the gains must be saved for investment. Diverting funds from consumption to investment may be well nigh impossible in the face of rising consumer aspirations. Moreover, dowries, elaborate wedding festivals, and conspicuous spending serve to divert potential investment capital from agriculture to less beneficial areas of expenditure.

Factor Productivity[8]

Factor productivity in agriculture varies widely between geographic regions. Productivity of each individual factor is determined principally by the amounts of the other factors accompanying it in the production mix. If, for example, small amounts of labor are used in conjunction with very large capital inputs and large quantities of land, then output per unit of labor input will be high.[9] But if, on the other hand, large inputs of labor are accompanied by little land and only meager inputs of capital, then output per unit of labor input will be low. The first example characterizes the developed regions, especially North America and Oceania. The second typifies the less developed regions, especially Asia.

Land

Land is a key factor in the production function for two reasons. First, it is in finite supply and second, the range of land productivity, i.e., yield, is limited. This is especially so when land productivity is compared with labor productivity.

The classic example of contrasting yields is that of rice in Japan and India. Yields in Japan average well over 4,000 pounds of rough rice per acre as compared with just over 1,000 pounds per acre in India. A comparable contrast exists between yields of corn in the United States and Mexico, leading producers of the principal grain in the Western Hemisphere. In recent years, yields have averaged 56 bushels per acre in the United States and 14 bushels in Mexico. This 4 to 1 yield ratio is almost exactly the same as that existing between two of the leading producers of rice in Asia. This ratio seems to represent the current maximum range in average yields between major producers of principal grains.

The variation between geographic regions in average yield of all grains considered aggregately, has a range nearly as large as that between countries as discussed above. North American grain yields, averaging 927 kilograms per acre in 1960/61, were almost exactly three times the 318 kilograms of Africa, the region with lowest average yields. (See table 21) The regional average yield differential is much greater now than prewar. Before World War II, Western Europe and Africa had the highest and lowest average yields with

[8] Measurement of output per unit of land and of labor actually measure output from factor mix. No attempt is made to allocate output according to each input factor.

[9] This assumes, of course, that the high capital inputs are accompanied by an advanced agricultural technology.

638 and 265 kilograms respectively. This represented a yield variation ratio of only 2 to 1, as compared with the more recent 3 to 1.

Average grain yields have risen over the past quarter century in each of the seven geographic regions but the rate of increase has varied widely. Regional increases range from 109 percent in North America to 7 percent in Asia. Measured in kilograms per acre, output rose 484 kilograms in the former region but only 34 in the latter. Corresponding figures for the more and less developed regions were 237 and 38 kilograms respectively.

Average annual yield increases, from 1934-38 to 1960/61, averaged 20, 10 and 8 kilograms per acre in North America, Western Europe and Oceania. The highest rate of increase in the less developed regions, however, was 2.2 kilograms per year in Africa. Progress in raising yields in the Soviet Bloc was not impressive, being in general more comparable to that of the less developed regions. A comparison of the yields per acre between the more and less developed regions shows an annual average increase of 10 kilograms and 1.6 kilograms respectively. Clearly the capacity to raise yields has been confined largely to the free part of the developed world.

Labor

Labor productivity in agriculture varies widely between geographic regions of the world (table 31). It varies even more between countries. Foremost among the many factors influencing the level of labor productivity are the size of the capital complement and area of land per agricultural worker. These influences seem to overshadow physical variations in arable land.

In agricultural productivity, as measured in terms of grain output per person in the agricultural population, North America is far and away the highest region (fig. 23). Grain output per capita of the farm population in 1960/61 ranged from 9,909 kilograms in North America to 294 kilograms in Africa. Oceania ranked second among geographic regions, with 3,667 kilograms per person. The other two developed regions, the Soviet Bloc and Western Europe, followed with 1,360 and 1,275 kilograms per person respectively. Grouped quite close together at the bottom of the list were Latin America, Asia and Africa with 389, 377 and 294 kilograms per person. The ratio between grain output per capita of the farm population in North America and the less developed regions is remarkably similar to the ratio of per capita incomes between these regions. This lends considerable credence to the thesis that progress in agriculture and progress in the total economy are closely related.

Table 31.--Productivity of agricultural labor, measured in terms of grain output per capita of farm population, by regions, average 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61

Regions	1934-38	1948-52	1957/58-1959/60	1960/61
	Kilograms			
Geographic regions				
North America	3,303	7,042	9,045	9,909
Latin America	403	326	382	389
Western Europe	882	929	1,217	1,275
E. Europe and USSR	956	964	1,273	1,360
Africa	205	244	281	294
Asia	309	299	362	377
Oceania	1,667	2,333	2,333	3,667
World	494	517	622	657
Economic regions				
Developed regions	1,228	1,589	1,991	2,167
Less developed regions	302	294	355	369
Political regions				
Free World	468	520	613	661
Communist Bloc	536	511	637	650
	Indexes (1934-38 = 100)			
Geographic regions				
North America	100	213	274	300
Latin America	100	81	95	97
Western Europe	100	105	138	145
E. Europe and USSR	100	101	133	142
Africa	100	119	137	143
Asia	100	97	117	122
Oceania	100	140	140	220
World	100	105	126	133
Economic regions				
Developed regions	100	129	162	176
Less developed regions	100	97	118	122
Political regions				
Free World	100	111	131	141
Communist Bloc	100	95	119	121

Derived from Tables 17 and 30.

Average grain output per person in the farm population was 2,167 kilograms in the developed regions in 1960/61 as compared with only 369 in the less developed regions. Production per person was 6 fold greater in the developed region. This compares with a prewar difference of 4 fold. Grain production per member of the agricultural population in the developed regions increased from 1,228 kilograms per year prewar to 2,167 in 1960/61, an increase of 939 kilograms or nearly 40 kilograms per year. The corresponding figures for the less developed regions were 302 kilograms per year prewar and 369 in 1960/61, an increase of 3 kilograms annually. Absolute gains in output per person in agriculture in the developed regions for 2 years is equivalent to the total gains for the 24 year period in the less developed regions.

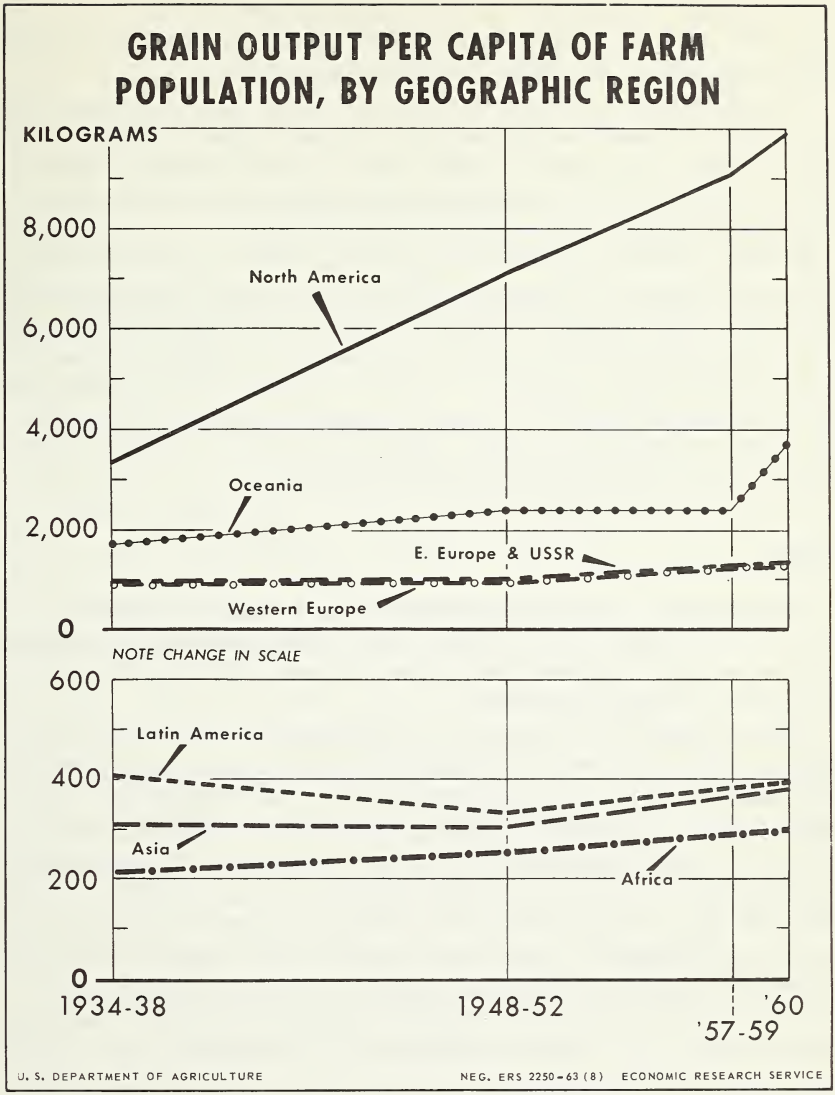

Figure 23

Gains in per capita output of the agricultural sector of North America averaged a phenomenal 275 kilograms per year from 1934-38 to 1960/61. This annual increase per person closely approximates the current total annual output per person in agriculture of the less developed regions. Not only did North America make the greatest absolute gains but the greatest relative gains as well. Output per worker tripled in North America and more than doubled

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in Oceania. All regions increased between prewar and 1960/61 except Latin America. Grain production per agricultural worker in this region in 1960/61 was still 3 percent below prewar.

A comparison of output per person in agriculture between the entire Free World and the Sino-Soviet Bloc shows the Free World with a slight edge of 661 kilograms to 650 in 1960/61. Prior to World War II, however, the Sino-Soviet region was more productive with 536 kilograms against 468 in the Free World.

In the world as a whole, gains in labor productivity from 1934-38 to 1960/61, amounting to 33 percent, were slightly greater than yield gains, which were 28 percent for the same period. Whereas yields gained in all seven geographic regions, however, labor productivity gained in only six, Latin America being the exception. North America, showing the greatest gains in both labor and land productivity, made relatively greater gains in labor productivity, 200 percent against 109 percent.

Capital

Productivity of capital inputs in agriculture is difficult to measure because of conceptual problems and scarcity of data. This discussion will therefore be confined to some general statements concerning capital productivity.

When capital for investment in agriculture is in short supply relative to land and labor, returns per unit of capital used are likely to be high. As capital inputs per acre rise, the returns per unit of capital must eventually decline. To cite a concrete example, returns per pound of fertilizer, a common form of capital input, remain rather constant as application rates rise until the amount used reaches a certain level, after which returns per unit begin to decline. Eventually a point is reached where output no longer responds to additional fertilizer inputs. It should be noted, however, that this will not soon be a problem in the less developed regions where capital, especially capital available for investment in agriculture, is in short supply.

Some forms of capital inputs in agriculture such as investment in agricultural research will earn positive returns of some magnitude within an almost unlimited range of investment. This particular area, (agricultural research) is, in fact, an area offering many opportunities for investment especially in tropical regions.

Factor Substitution

The relative amounts of the three input factors--land, labor and capital--used in the agricultural production mix in a given country or

region are largely determined by the relative availability of the factors. In general, the more plentiful a given factor is, the less costly it is and the more it is used. Farmers, to the extent that knowledge permits, attempt to find the least costly combination of factors. This enables them to produce at the lowest possible cost or, stated otherwise, in the most efficient manner.

As agricultural output expands, the need for the individual input factors expands. The supply of some factors can be increased more readily than others. This leads to differences in relative availability of the production factors. And this in turn leads to a change in relative costs and the least-cost combination of inputs. It is this readjustment of the factor mix that requires substitution of one factor for another.

Certain predictable changes occur in the development process with regard to the relative availability of the factors. In the early stages capital is scarce, land is gradually becoming more scarce, but labor is plentiful. As the economy develops and population grows, factor relationships change. In the more advanced stages capital is in plentiful supply, land is much more scarce, but labor for agriculture is still relatively abundant. As development occurs, capital is substituted for labor and to a lesser extent for land. Capital can be more readily substituted for labor, however, than for land. After a certain stage is reached in the development process, the labor share of the production mix begins to decline. At a still later point, not only the labor share, but the actual quantity of labor used, begins to decline although output continues to rise, perhaps even at an accelerated rate. Capital can be substituted for agricultural labor to the extent that food output per worker can demonstrably be expanded 30 fold. Such is not the case for land, at least not with existing technologies and cost structures; grain output per acre varies no more than 4 to 1 between major producing regions.

If population pressure becomes intense early in the development process and the per capita land area declines rapidly before the capital supply begins to grow significantly, it becomes necessary to substitute labor for land. Limits are soon reached in substitution in this direction, however, as returns per additional unit of labor input will quickly approach zero unless additional capital inputs are forthcoming. If the substitution of labor for land does not result in considerable gains in per capita income, the capital needed as a substitute for labor cannot be accumulated. A country in these circumstances can be described as caught in the low income trap. Clearly many still underdeveloped countries are, and have been for some time, trapped in this position. Stated otherwise, these countries have not generated enough savings to reach the "takeoff" point.

Chapter IX.--SELECTED AGRICULTURAL PROBLEMS

Developing a Tropical Technology

A tendency exists among less developed countries to spend little or nothing on research, looking always to the developed countries for new technology. This approach presents some inherent difficulties for the agricultural sector since agricultural technology is not as readily transferred as industrial technology. The manufacture of steel or the weaving of textiles involves essentially the same technology in all countries regardless of the stage of development. In fact, in some cases an underdeveloped country just entering an industry may be in a better position to benefit from recent technological advances than a developed country with its older plants, constructed and organized on the basis of an earlier technology.

Historically, the early application of the scientific method to agriculture occurred in those countries of temperate, Northwestern Europe where the industrial revolution occurred. Those emigrants leaving northwestern Europe and settling in temperate regions such as North America, Australia and New Zealand were able to apply their knowledge of advanced agricultural techniques, with minor modifications, to considerable advantage. For those going to tropical and subtropical lands, however, this ready transfer was not possible. Nearly all the less developed countries are situated in the tropics and subtropics and the crops and types and breeds of livestock indigenous to these areas are different than those of the developed countries located largely in the temperate zones.

In general, agricultural research must be undertaken by governments, at least in the early stages of development. Individual farmers lack the technical and financial resources required to do effective research. Collective action is required and in most countries only government can provide this. As a country reaches the advanced stages of development, private corporations, depending upon the farmer as a market, or looking to him as a supplier, often assume a major part of the agricultural research load, particularly in specialized areas of interest.

With the demand for food boosted at least by the extent of annual population growth and perhaps somewhat more if incomes rise, the

supply of food must increase. In the past most of this needed increase in the less developed regions occurred as a result of expanding the planted area. From 1934-38 to 1960/61 grain output rose 42 percent in the less developed regions. About 80 percent of this total gain was due to expanding the cultivated area and the remainder to increasing yields. Future gains in output will depend more and more on raising yields as the supply of new arable land is exhausted. To achieve this greater yield potential will require changes in the patterns of inputs and this in turn will require attendant changes in technology. These changes will involve the substitution of both labor and capital for land. The goals of research in tropical agriculture, then, will be the development of labor intensive techniques and the most effective way of using more capital inputs such as fertilizer, pesticides, improved seeds and irrigation.

Another factor limiting the transfer of technology derives not from the climatic conditions but from the pronounced difference in the man-land ratio in the world's two dominant economic regions. The per capita area planted to grain in the advanced countries averages .85 acres per person as compared with only .43 acres in the less developed regions. Agricultural research in the developed regions, largely temperate, is oriented largely toward maximizing output per person. Research in the less developed region, if it is to be useful, must be directed at obtaining the greatest possible output per acre, for land, not labor, is the limiting factor. Japan, with a population of 94 million--just over half that of the United States--compressed into an area smaller than California--has pioneered in agricultural research designed to maximize land productivity. Unfortunately, however, Japan is not a tropical country, hence some of the technology developed is no more easily transferred to less developed regions than that of the industrial west.

The Current Agricultural Effort

The current agricultural effort varies widely among regions of the world. In North America and Oceania efforts are excessive and unnecessarily large food stocks have accumulated. Agriculture in Western Europe appears to be performing well; output, yields and diets are improving. Agriculture in the Soviet Bloc has not fared well; output and yields have not improved commensurately with the resources available. Diets are adequate but monotonous, with the share of starches in the diet remaining inordinately high.

The situation in the underdeveloped regions is quite different. If the magnitude of the effort is to be judged by need, then efforts have

been grossly inadequate. In these areas output of grain per capita of the total population is lowest, and in Asia and Latin America it has actually trended downward over the past quarter century. Between prewar and 1960/61, per capita grain output, a useful indicator of overall food output, dropped from 254 to 214 kilograms in Latin America and from 231 to 226 kilograms in Asia. Diets are clearly inadequate in the underdeveloped regions and the number of ill-nourished people is growing rather than diminishing.

Several factors account for the lack of effort and accomplishment in agriculture. One of these is the strong competition throughout the economy for the limited available resources. Another is the view prevailing in underdeveloped countries that progress means expanding the industrial sector while neglecting agriculture. There seems to be little appreciation of the relationship between a viable, progressive agriculture and a progressive economy. The importance of this relationship is strongly supported by the fact that virtually every currently advanced country first had an improving agriculture as a precondition. Also, agriculture lacks status in most underdeveloped countries and most of those young people fortunate enough to attain a higher education do not elect to work in agriculture.

The Rising Cost Curve

The rising cost curve in agriculture is closely associated with the law of diminishing returns. This law, set forth by Alfred Marshall, states:

> "Whatever may be the future developments of the arts of agriculture, a continued increase in the application of capital and labor to land must ultimately result in a diminution of the extra produce which can be obtained by a given extra amount of capital and labor." (43 p. 153)

Many have contended that Marshall overstated the case for diminishing returns in agriculture. Those of this persuasion often insist that the law is applicable only when technology is constant. It is not likely, however, that a changing technology can do more than partially offset the tendency to diminishing returns.

During the several decades that have lapsed since Marshall's initial formulation, arable land/man ratios have declined considerably, especially in Western Europe and Asia. Japan, a country with a long record of population growth and a steadily declining area of arable land per capita provides an excellent historical example. The .12 acres of arable land per capita in Japan is only a small fraction of the world average of nearly one acre. In spite of this limited land availability, the Japanese have managed to attain

domestic self-sufficiency in rice, their principal food. This remarkable achievement has been costly, however, requiring gradually rising rice support prices now at least two or three times as high as average world price. Production costs in other densely populated countries such as the United Kingdom would undoubtedly be at a comparable level if they were to attempt to attain self-sufficiency in their principal food staple.

The cross sectional or international data on wheat and rice producer prices provide rather comprehensive support for the law of diminishing returns (tables 32 and 33). The distributions, presented in figures 24 and 25, between average per unit producer prices and arable land per capita by country for wheat and rice suggest a surprisingly close relationship.[10]

Table 32.--Average producer prices for wheat and arable land per capita in selected countries, 1959

Country	Wheat prices	Arable land per capita
	U.S. Cents/Kilogram	Acres
Algeria	7.6	1.6
Australia	6.2	6.6
Belgium	9.4	0.3
Canada	5.4	5.8
Chile	6.7	1.8
France	7.7	1.2
West Germany	10.1	0.4
India	9.0	0.9
Ireland	8.1	1.2
Italy	10.4	0.8
Japan	10.2	0.2
Mexico	9.3	1.5
Netherlands	8.0	0.2
Pakistan	7.2	0.7
Sweden	8.3	1.2
Turkey	6.1	2.3
Republic of South Africa	8.5	1.8
Egypt	7.7	0.3
United Kingdom	7.5	0.3
United States	6.4	2.6

Source: FAO Production Yearbook, 1960.(15)

[10] The widest range of comparable data for leading food commodities such as wheat and rice exists in the form of prices rather than actual costs. For the purposes of this exercise it is assumed that price data at the producer level are not unreasonable indicators of production costs. Support prices within any given country tend to weaken the relationship between producer prices and costs of production but not enough to appreciably alter the comparison between countries with widely varying land/man ratios.

Table 33.--Average prices for rice and arable land per capita in selected Far Eastern Countries, 1959

Country	Rice prices (paddy)	Arable land per capita
	U.S. cents/kilogram	acres
Burma	3.0	1.0
Thailand	4.5	1.1
India	5.2	.9
Ceylon	12.1	.4
Japan	17.7	.2

Source: FAO Production Yearbook, 1960 (15)

In viewing the cross sectional distribution, it is interesting to conjecture as to just where the world average production costs for these commodities would be on the curve. The curves formed by these distributions should reflect the shape of the long-term food production cost curve along which world average production costs would be expected to move over time as the arable land/man ratio continues to decline. Of particular note in this respect is the steepness of the rise in the cost curve as arable land per capita drops below 2 acres for wheat producing countries and 0.5 acres for rice producing countries.

These two commodities, wheat and rice, were selected because they are the principal food staples, each supplying about one-fifth of man's food energy supply. Prices used are generally producers' prices or prices as near the farm as possible. Only major producing countries are considered. In the case of rice this limits the selection to Asian countries, for this region accounts for 92 percent of world output. Variations between the arable land/man ratio within Asia are, however, adequate for this exercise. Local currency prices are converted to U.S. dollars, for all countries included in the distribution, by the Food and Agricultural Organization of the United Nations. Rice price data are particularly complicated because of the wide variation in types and grades of rice. For this reason, selection of rice producing countries was limited to those countries with prices available for paddy.

Transferring Food or Resources

The current world food problem is partly a matter of maldistribution. It is well recognized that the areas of greatest projected population growth and those with the greatest agricultural production

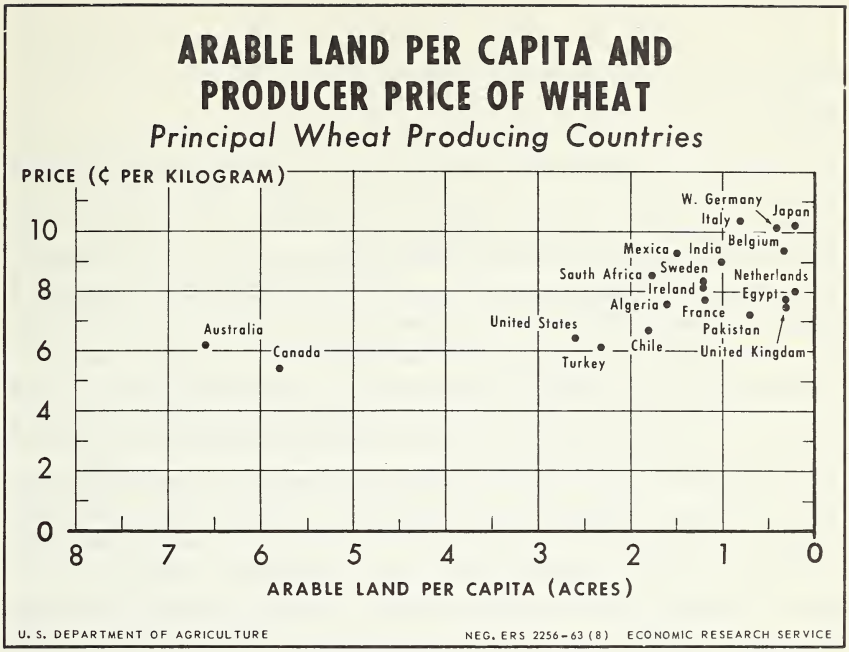

Figure 24

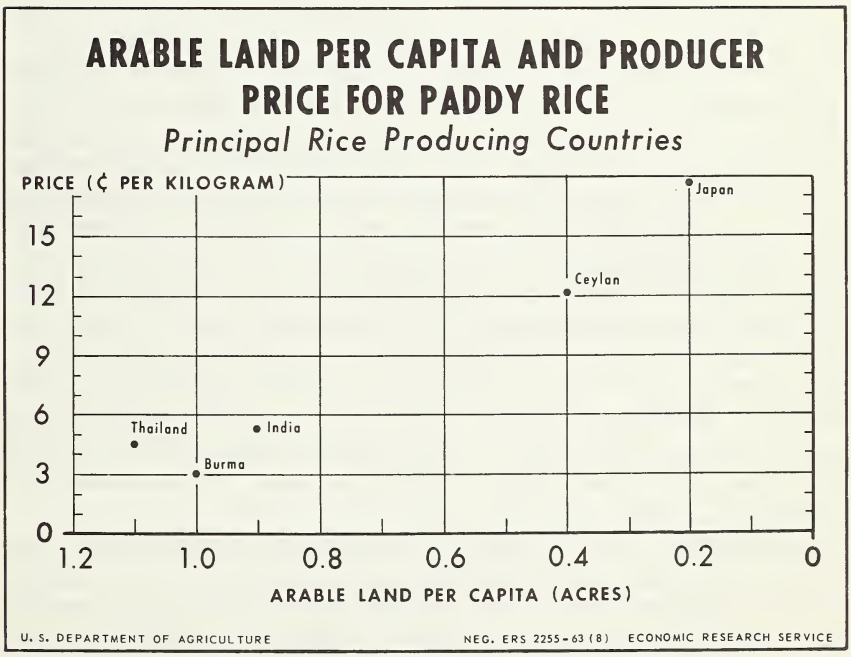

Figure 25

potential are not the same. With population growing most rapidly in the less developed regions and the potential for producing food growing faster in the developed regions, the food distribution problem is becoming increasingly acute.

Prior to World War II, per capita annual grain output averaged 224 kilograms per person in the less developed regions, compared with 470 kilograms in the more developed regions. Since the prewar period, the gap has steadily widened as the advanced countries have forged ahead rapidly while the less developed regions have struggled to maintain the status quo. As of 1960/61 the figures were 218 kilograms versus 593--the developed regions were close to tripling per capita output of the less developed regions.

During the late 1930's, there existed a net annual flow of some 11 million metric tons of grain from the less developed to the more developed regions. By the end of the war the flow had been permanently reversed and in 1960/61 the flow from the developed to the less developed regions had reached 20 million tons. The less developed regions were exporting 8 kilograms per capita annually in 1935-39 but in 1960/61 they were importing 9 kilograms per capita. This shift in direction of flow of grain permitted the less developed regions to raise per capita availability slightly while per capita output was declining.

There are three possible ways in which the food problem might be alleviated. The first--large scale migration from the deficit, less developed regions to the surplus, more developed regions can be ruled out on the grounds of being impracticable from a purely logistical point of view and unacceptable from a political standpoint. The two remaining possibilities--transferring food or transferring the wherewithal to produce food--warrant serious consideration.

The transfer of food, is perhaps the simplest and most expedient but it can cope with the problem only in a minor way. Over the long term the less developed regions must solve most of their own food problems. But to do it without experiencing widespread food shortages, hunger and possible famine, they must receive assistance. Much assistance is needed in organizing agricultural credit, extension advisory services, agricultural training centers and the marketing systems to provide the incentive for production beyond the subsistence level. Then capital inputs such as fertilizer and pesticides will have to be supplied at least in part, from the developed regions.

Developing countries, almost by definition, experience chronic balance-of-payments difficulties. Foreign exchange earning capacity is seriously limited and scarce foreign currency reserves must be used to import capital goods and service standing international loans. A large share of the total foreign exchange earnings of countries

like India will be required for servicing of international debts only a few years hence if they are not to default.

The relative dependence on direct shipments of food as against the provision of economic and technical assistance should depend at least partly on the relative level of production costs in the individual developing country. If a country is on the upper part of the cost curve discussed earlier in this chapter, and this is usually a result of a very low and declining amount of arable land per capita, then relatively more emphasis should be given to shipping food while the recipient country builds its industry. In these countries where food imports are used to directly finance construction projects, the above criterion is not so relevant. Industrial development is an area of endeavor in which the restricted amount of arable land per capita is not a serious handicap. On the other hand those countries with much larger amounts of arable land per person and an assumedly favorable agricultural resource endowment otherwise, should be encouraged to push the development of their own agriculture rather than become dependent on the advanced countries for a large share of their food supply.

The blanket assumption that all countries in the less developed regions should strive to be self-sufficient in food has little foundation in economics. Neither can it be assumed that all less developed countries can benefit indefinitely from shipment of surplus foods when, with a little more technical and economic assistance, some could be self-sufficient in food with a very low production cost per unit.

An example of a country, though by no means an underdeveloped one, which finds it very costly to maintain near self-sufficiency is Japan. The Japanese are about 80 percent self-sufficient in all agricultural products but virtually self-sufficient in rice as of the last few years. Self-sufficiency in rice, the principal food staple has been extremely costly, for it requires support prices at levels two or three times as high as those of the world market. If a country in a very early stage of development were forced as high on the food production cost curve as the Japanese, the use of their total national resources in food output alone might not be sufficient to sustain a given level of population. To encourage a country to attempt this would certainly be unwise from a policy point of view. Many underdeveloped countries, however, may find themselves in a similar position on the production cost curve before they reach the point where a sustained, rapid rate of economic growth is achieved.

In summary, the disparity between distribution of food and people must be alleviated in the long run largely by a lower rate of population growth and by know-how, capital and the general wherewithal to produce more food. Direct shipments of food are important but in the long run their role can be only minor in solving the long term food problem.

Chapter X.--TWO WAYS OF INCREASING OUTPUT

Agricultural output can be increased either by expanding the cultivated area or by increasing yields. Throughout much of man's history yields have remained rather constant, at low levels. Only over the last two centuries, and especially the last two decades, have average world yields begun to make consistent gains. Historically, then, gains in agricultural output have been closely associated with additions to the cultivated area.

Data in tables 17, 19, and 21 on world grain production, harvested area and yields show rather conclusively that since about 1950, additions to world grain output have, for the first time, occurred more as a result of raising the yields than of expanding the cultivated area. Since the 1948-52 period, nearly four fifths of the gains in grain output have come from yield increases.

Expanding the Cultivated Area

Regional trends and possibilities

It is now evident that progress in expanding the world food supply is dependent more on raising yields than on further expanding the area under cultivation. The four geographic regions classified as developed--North America, Western Europe, Oceania, and the Soviet Bloc--have been largely or entirely dependent on yield increases for additional grain output over the past quarter century.

All three less developed geographic regions--Asia, Africa, and Latin America--have been more dependent on additions to the planted area than on yield increases, over the past quarter century. During the last decade, however, Asia became more dependent on rising yields than on expansion of area. Asia is now one of the most land-scarce regions; all evidence indicates that yield increases must be the principal source of future gains in food output. India, for example, expects to make only negligible additions to the cultivated area over the next 15 years, according to drafts of the next three 5-Year Plans. Pakistan is experiencing a steady loss of good farmlands due to waterlogging and salinity, which tends to offset

new land brought under cultivation elsewhere in the country. Japan's cultivated land area has been steadily declining for decades. Communist China cannot practically expand cultivated area much further. A few countries, mostly smaller ones such as Thailand, Burma, Malaya, Indonesia, and the Philippines, do have considerable future land expansion potential, but the rate at which new land can be brought into cultivation is restricted by the limited capital available for that purpose.

Africa and Latin America have been historically more dependent on additions to the cultivated area than on yield increases. This greater relative dependence on additions of new land will not, however, likely continue much longer in either region.

Selected major countries

This section is designed to focus attention on the potential for expanding planted area in four major world agricultural producers for which data are available. The four countries selected are the United States, the Soviet Union, India, and Japan.

The long-term trends in the United States, the world's number one agricultural producer, indicate a steady decline in the area of cropland harvested. Harvested acreage followed an irregular upward trend from early colonial days, reaching a peak shortly after World War II. Throughout the 1950's and early 60's, however, this trend has been reversed with the area of cropland harvested dropping from a high of 350-60 million acres in the late 1940's to less than 300 million acres in the early 1960's.

This pronounced decline is attributable to several factors. The widespread adoption of fallowing in the vast grain producing area between the corn belt and the Rocky Mountains has reduced the annual grain planted area by several million acres. In other regions of the country, notably New England and the Southeast, some marginal farm land has been abandoned. Sizable areas of land are being lost to nonfood uses such as highways, parks, and residential and industrial expansion. Still more land is being withdrawn from use as a result of government production control programs designed to reduce surpluses.

The combined effect of these developments is a steady shrinkage of the land actually being used for crop production. Despite this it should be noted that the technical possibilities for expanding the cropped area exist if the demand becomes sufficiently strong.

Data on harvested or planted cropland area are much less complete and reliable for the Soviet Union than the United States. Certain things, however, are evident. A major effort has been made to expand the sown area during the 1950's. Equally evident is the fact that the

sown area may have been overexpanded in some areas, particularly the lower rainfall areas. Much of this land may in the long run prove submarginal. Fallowing is likely to become increasingly necessary in the Soviet Union as it has in the lower rainfall grain-producing areas of the United States. Some land initially brought under cultivation in the virgin lands will undoubtedly prove unsuitable for cultivation and be abandoned.

The current trend in sown area in the USSR seems to be still rising although much more slowly than in the past. D. Gale Johnson in looking ahead to 1985 sums up the situation as follows . . . .

> "There seems little prospect for further large increases in the sown area. Barring extensive drainage and clearing of forests in the northwest, the sown area is not likely to increase by more than 10 percent or 20 million hectares (50 million acres)". (34, p. 253)

This would seem to be the maximum which could possibly be added to the sown area.

Net area sown in India at the beginning of the third 5-Year Plan in 1961 amounted to 322 million acres. The area scheduled for reclamation during the Third, Fourth and Fifth Plan is 2 million acres per plan or an average of .4 million acres per year. This 6 million acres added to the 322 million net acres sown in 1961 would bring the total up to 328 million by 1975, an increase of 2 percent or about 0.1 percent per year. A comparable area, totaling 6 million acres, is scheduled to be withdrawn from fallow over the 15 year period. Adding a total of 12 million acres in 15 years amounts to 0.8 million acres per year or an average annual increase in net area sown of 0.24 percent.

Population is expected to grow 2.5-2.7 percent annually throughout the period or 10 times faster than the sown area. Clearly if per capita output is maintained it must be done by raising output per acre, and at more than 2 percent per year.

Japan, unlike India, can no longer expand the area under cultivation even with massive government expenditures. Cultivated area reached a peak in Japan around 1920 and has been gradually shrinking for the four ensuing decades. Population meanwhile has been steadily growing and as it has grown, nonagricultural land requirements such as housing, industry, highways, and airports have steadily encroached on the cultivable land area. From 1920 to 1960 Japan lost an average of 49 thousand acres per year. If this trend continues, the cultivated area will drop to 12 million and 11 million acres by 1980 and 2000, respectively. This trend would cause Japan either to become increasingly dependent on external sources of food or, alternatively, to accept the higher cost associated with attempting to extract more and more food from a shrinking land area.

Using Existing Land More Intensively

Using land more intensively means using more labor and capital per unit of land. Additional inputs of labor and capital are not too effective, however, unless used in combination with improved technology. All of the following practices--multiple cropping, fertilization, irrigation, use of pesticides, use of improved seeds, and mechanization--involve the use of more capital. All but the last two, the use of improved seeds and mechanization, also require more labor.

Multiple cropping

Multiple cropping is a practice deserving considerable attention as it becomes necessary to obtain a greater output from a limited amount of land. Multiple cropping is not, however, a simple matter of just planting more than one crop per year. It requires substantially greater inputs of capital and labor and more sophisticated management practices.

Many physical factors operate to limit multiple cropping. Temperature limitations are perhaps the most common. Much of the currently developed world is situated in the temperate zone. Winter temperatures in this region are so severe that only the most hardy crops can survive. Not only are winters severe but in the higher latitudes of the north temperate zone, the summer growing season is quite short, permitting cultivation of only one short-season crop.

In the middle latitudes where year round temperatures are satisfactory, rainfall may be a limiting factor, at least for part of the year. Many areas in the tropics with relatively warm year round temperatures have monsoon climates, characterized by heavy summer rainy seasons followed by an annual dry season of several months duration. The wet season is ideal for rice cultivation but crops can be successfully grown during the dry season only if irrigation is available.

The science of multiple cropping is highly developed in some countries, particularly in East Asia. The index of multiple cropping is highest in Taiwan, where farmers get an average of nearly two crops per acre per year. Multiple cropping is also widely practiced in Japan and Korea where 50-60 percent of the cropland produces two crops. Mainland China, too, stands out with 40 percent of the land producing two crops. India, on the other hand lags, for only 10-15 percent of the land grows two crops. Some countries, such as Burma, with large areas of land fallowed, average less than one crop per acre of cropland yearly. (6, p. 12)

Multiple cropping requires more inputs of labor and capital per acre of land. Because of this, labor and some capital inputs are more efficiently used. Seasonal unemployment is reduced and draft animals can be worked the year around.

To what extent multiple cropping is possible and practical in other tropical and subtropical regions, is difficult to say. Suffice it to say that the availability of capital inputs such as fertilizer must increase and that management techniques must be improved before any significant advances can be made.

Fertilization

As new farmland becomes scarce and output can be increased only by raising yields on existing cropland, fertilizer assumes a much more critical role. Just what share of current world food output is attributable to the use of fertilizer is difficult to say. Certainly if the 6 kilograms of fertilizer used per acre of grain in the less developed regions were suddenly withdrawn, grain output would not be greatly reduced.[11] In the developed regions, however, the 33 kilograms of fertilizer used per acre of grain must account for a sizeable share of total output. The importance of fertilizer in the future will be much greater than in the past.

World fertilizer consumption in 1960/61, measured in terms of the three major nutrients--N, P_2O_5 and K_2O--was 28.6 million tons (table 34). This was twice that of 1950/51 and three times prewar. Each of the three major nutrients was well represented, contributing 35, 35, and 30 percent respectively of the total (See tables A10 to A12). Consumption according to region was no so equal, however. Western Europe, consumed 10 million tons or 35 percent of the total though having only 6 percent of the world grain acreage. North America was second with 7.5 million tons. Together these two regions, with only 21 percent of the grain acreage used 61 percent of the available fertilizer supply in 1960/61.

The developed regions, with 45 percent of the grain acreage, used 82 percent of the world fertilizer supply. The less developed regions, with 55 percent of the grain acreage, used 18 percent. This amounted to 33 and 6 kilograms per acre of grain in the two respective regions (table 35). Application rates in the Free World and Communist Bloc countries are 23 and 9 kilograms per acre respectively.

[11] Total fertilizer consumption is divided by area in grain rather than arable land area or some other less precise figure.

Table 34.--Consumption of chemical fertilizers (N, P_2O_5 and K_2O), by regions, 1938, 1950/51 and 1960/61

Region	1938	1950/51	1960/61
	Thousand metric tons		
Geographic regions			
North America	1,416	4,700	7,541
Latin America	82	290	999
Western Europe	4,119	5,814	9,998
E. Europe and USSR	2,544	2,087	5,127
Africa	200	360	720
Asia[1]	1,030	1,070	3,290
Oceania	380	530	930
World	9,771	14,851	28,605
Economic regions			
Developed regions	8,459	13,121	23,596
Less developed regions[1]	1,312	1,720	5,009
Political regions			
Free World regions	7,227	12,764	23,478
Communist Bloc[1]	2,544	2,087	5,127

[1] Excludes Communist China but amount of chemical fertilizer used by this country is not large relative to the regional total.

Source: Appendix tables A10, A11, and A12.

Many things affect the general response of crops to fertilizer in a given country or region. One of these is rainfall. Moisture must be available if plants are to absorb the supplied nutrients. In regions with only 10-15 inches of rainfall per year, fertilizer is largely ineffective unless supplemented by irrigation. The prevailing abundance of moisture throughout most of Western Europe enables farmers to effectively utilize more fertilizer than in many other less fortunate regions.

Different varieties of grain often have widely varying degrees of responsiveness to fertilizer. Traditional, unselected varieties of many crops often show little or no response. Developing varieties with a high degree of response to fertilizer then becomes a priority item on the agricultural research agenda. The development of highly responsive rice varieties in Japan has enabled farmers to increase steadily the amount of fertilizer they can effectively use.

Current fertilizer utilization in the less developed regions is only a very small fraction of potential utilization. The extent of this unrealized potential may be illustrated by comparing the rate

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Table 35.--Chemical fertilizer (N, P_2O_5 and K_2O) used per acre, by regions, 1938, 1950/51 and 1960/61[1]

Regions	1938	1950/51	1960/61
	------Kilograms------		
Geographic regions			
North America	6	18	32
Latin America	1	4	11
Western Europe	39	60	100
E. Europe and USSR	7	6	14
Africa	2	3	6
Asia[2]	2	2	5
Oceania	24	35	44
World	7	10	18
Economic regions			
Developed regions	12	19	29
Less developed regions[2]	2	2	6
Political regions			
Free World	8	4	23
Communist Bloc[2]	5	4	9

[1] Calculated on basis of total acreage planted to grain.

[2] Excludes Communist China but amount of fertilizer used by this country is not large relative to the regional total.

Derived from tables 19 and 34.

of consumption in Japan with that throughout the less developed regions. Japan, with its limited cultivated area, uses more fertilizer than Latin America or Africa. It uses more than China or India, even though its cultivated area is only 5 percent of China's and 4 percent of India's. If fertilizer application rates in India, for example, were to reach those of Japan, India's requirements would far exceed present total world output.

Many factors have hindered the expansion of fertilizer consumption in the less developed regions. Chief among these are: a lack of distribution facilities; inadequate knowledge on the part of the farmers of the value of fertilizers; an inadequate knowledge of methods of application; price instability of crops; insecurity of tenure; the lack of fertilizer production facilities or alternatively a shortage of foreign exchange; and a paucity of short-term agricultural production capital.

The extended use of fertilizer is strategically important, for, in areas of adequate moisture, it is the primary means of achieving

higher yields and greater overall food production. This assumes, of course, that fertilizer will be used in combination with other improved techniques.

Irrigation

Some regions of the world are much more dependent on irrigation than others (table 36). Western Europe, except for some of the Mediterranean countries, has very little irrigated land. Asia on the other hand, is heavily dependent on irrigation. Communist China, with the largest irrigated area of any country and India, with about one-fifth of its land irrigated, have collectively about half of the world's irrigated land. Japan and South Korea, though quite small by comparison, have half or more of their cultivated land under irrigation. Egypt, also a relatively small country, has virtually all its farmland under irrigation. Other countries with extensive irrigated areas are the United States, Pakistan, Indonesia, the Soviet Union, and Mexico. Most of the world's irrigated land is in Asia and by far the greater part is used to produce rice.

Irrigation systems vary widely even within regions. All systems must incorporate some means of moving the water from the storage area or point of diversion to the irrigated field. Gravity feed, one of the oldest methods, is also one of the most common. Ponds, reservoirs or diversion dams are situated at points higher than the field and controlled gravity flows are used to move water to the field. Large scale cooperative efforts among farmers are often required in the distribution and sharing of water.

When gravity feed cannot be used farmers must rely on some source of power for lifting water. Modern machines are now widely used, especially in the more advanced countries. Many farmers in the underdeveloped regions, however, do not have access to electricity and cannot afford internal combustion engines. These farmers, most of whom are in Asia, must rely on the traditional sources of human or animal power. In East Asia, especially China, the centuries-old waterwheel, turned by a human-powered treadmill process, is still quite common. This method of lifting water requires an enormous expenditure of human effort. The Persian waterwheel, an ancient animal-powered waterlift, is widely used in the Middle East and Indian subcontinent.

Water used for irrigation comes from two principal sources, surface and underground. Rivers are the leading single source. Wells and ponds are important secondary sources.

A look at irrigation in the future must focus on two things--the potential for expanding the irrigated area and the cost of expansion.

Table 36.--Area of irrigated land in selected countries, 1950-60

Country	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960
	Thousand acres										
North America											
Canada	--	628	628	628	628	628	628	--	--	--	--
United States	26,427	25,785	--	--	29,551	29,551	--	--	--	33,005	--
Latin America											
Argentina	--	--	2,471	3,583	3,583	3,583	3,706	3,706	--	--	--
Bolivia	124	124	124	--	158	158	158	--	--	--	--
Brazil	326	336	348	348	348	348	348	--	--	--	--
Chile	3,212	--	--	3,366	3,366	3,366	3,368	3,368	--	--	--
Colombia	180	193	208	--	--	--	1,248	--	--	--	--
Mexico	5,199	5,668	6,187	6,187	6,187	6,187	6,187	--	--	--	--
Paraguay	30	30	30	30	30	30	30	--	--	--	--
Peru	2,965	2,980	2,995	2,995	2,995	2,995	2,995	--	--	--	--
Uruguay	40	40	44	54	57	62	64	--	--	--	--
Venezuela	--	583	--	544	608	608	608	--	--	--	--
Western Europe											
France	27	44	54	47	49	49	57	67	72	79	82
Greece	--	660	672	704	739	773	840	899	939	988	1,013
Italy	353	385	430	435	440	418	341	311	331	336	319
Portugal	67	77	84	82	89	89	96	91	86	89	91
Spain	--	--	--	--	4,035	4,151	4,240	4,329	--	4,413	4,517
E. Europe and USSR											
Bulgaria	--	--	--	618	618	890	--	702	724	981	--
Hungary	--	42	42	67	104	224	220	193	178	180	235
Romania	--	--	--	--	--	230	230	242	252	339	494
USSR	--	--	--	--	--	27,497	--	17,816	--	--	--
Yugoslavia	--	--	--	--	161	240	252	205	222	220	289

Africa											
Algeria	--	--	111	119	109	--	--	499	608	618	--
Egypt	--	6,056	6,056	6,360	6,469	6,467	6,449	6,449	--	--	--
Ethiopia	25	25	37	37	37	106	116	109	119	--	--
Madagascar	652	652	652	652	652	652	--	--	--	1,769	1,779
Morocco	--	12	12	148	148	--	--	--	--	1,226	1,285
Somalia	--	148	213	227	230	240	319	361	--	393	408
Sudan	--	--	--	--	5,953	5,953	--	--	--	--	1,952
Asia											
Burma	1,240	--	1,300	1,339	1,337	1,213	1,280	1,334	1,287	1,240	1,347
Ceylon	452	410	588	487	655	722	546	615	615	630	--
India	--	51,528	51,995	52,405	53,833	54,261	56,235	55,682	57,199	57,898	--
Indonesia	11,811	12,222	12,577	12,577	12,577	12,577	14,087	14,203	14,613	14,712	--
Iran	3,706	3,954	3,954	3,954	3,954	3,954	--	--	--	6,820	7,166
Iraq	4,324	--	--	7,196	7,196	7,196	6,919	--	--	9,081	--
Israel	109	126	148	178	210	232	262	282	294	311	326
Japan	7,055	6,986	7,047	7,047	7,047	7,047	--	--	--	--	8,322
Jordan	--	--	79	79	79	79	188	--	--	--	--
Korea, South	--	--	1,408	--	--	--	1,315	1,374	2,965	2,997	3,005
Lebanon	119	119	119	119	119	119	175	175	175	175	178
Malaya, Fed. of	321	287	287	--	--	--	474	504	521	521	--
Pakistan	22,711	22,711	22,182	22,182	22,812	23,445	23,489	24,836	24,799	27,354	--
Philippines	1,280	1,391	1,549	1,863	1,893	1,952	2,157	--	--	1,641	1,997
Syria	976	1,161	1,216	1,258	1,270	1,458	1,685	1,441	1,470	1,176	1,302
Thailand	1,485	--	2,184	--	2,093	3,005	3,151	3,296	3,262	3,800	--
Turkey	198	--	267	--	--	4,769	4,843	4,912	--	--	--
Oceania											
Australia	1,512	1,512	1,527	1,473	1,614	1,740	1,270	1,621	1,997	1,905	2,093
New Zealand	106	99	109	111	101	--	--	161	146	166	--

Source: FAO Production Yearbooks, 1955-1961, table 2 (15).

The potential for expanding the irrigated area is ably discussed by Herbert Addison, a hydraulic engineer with a lifetime of experience in various parts of the world. (1, p. 268) He sets forth the following conclusions regarding the historical progress and present and future status of land reclamation.

(1) Less than 10 percent of present world food production comes from irrigated or artificially drained land.

(2) Less than 5 percent of this total food supply depends upon the control of water on an engineering scale.

(3) Of the estimated increase in world food production during the next half century, not more than one-tenth of this total can be expected as a result of new large-scale engineering works.

Efforts to increase anything indefinitely usually result in rising costs per additional unit. The law of diminishing returns is no less applicable to irrigation than to food output as described by Marshall in his original example. (43, p. 153) Addison brings his experience to bear on this problem, too, as he observes:

". . . newcomers [farmers of the future] may have enjoyed far better educational opportunities than their predecessors; but on the other hand the demands on their resourcefulness may be more severe."

"Unquestionably they will meet with increasingly adverse conditions when lift irrigation is to be practiced. There will be a growing tendency for the cost of lifting water to become unduly burdensome. Underground water resources must necessarily be exploited more and more as free-flow or gravitation becomes less practical; and probably as pumping goes on year after year, the water table will sink and a rising in pumping costs will automatically follow. Even when open streams remain available, there may be no new ground at a low level that can be put under irrigation: the water therefore must be lifted to higher ground." (1, p. 256)

The point at which irrigation becomes too costly varies with the component costs of pumping such as fuel cost and cost of pumps on one hand and the level of agricultural prices on the other. In countries where population is pressing heavily on the land, the level of agricultural prices may be such as to afford more costly irrigation. Also in densely populated countries striving for a certain level of self-sufficiency, even relatively costly irrigation may be the most economic method of expanding output.

The Indian National Council of Applied Economic Research in its agricultural projections draws attention to the rising costs per acre associated with expanding the irrigated area. Costs per acre are estimated for land scheduled to be irrigated by minor projects between 1960/61 and 1975/76. The average cost of irrigating an

acre from minor projects, estimated at 160 rupees in 1960/61 is expected to rise to 280 by 1975/76. (30, p. 234) On the basis of evidence available from other Asian countries, this 75 percent cost increase does not seem unreasonable.

Pesticides

Most pesticides may be variously classified as insecticides, fungicides or herbicides. Insecticides and fungicides may be grouped with those capital inputs usually described as yield-increasing; herbicides are more often labor-saving. Stated otherwise, it is not usually possible to control pests and diseases caused by fungi except by using insecticides and fungicides. Weeds, on the other hand, are usually readily controlled by hand. Where labor is plentiful and inexpensive, as in most underdeveloped countries, it may not only be possible but also more economical to weed by hand.

As economies develop and agriculture becomes more and more specialized, problems of controlling insects and disease multiply, both because of the growing concentration of particular crops in localized areas and because of the great ease with which pests are transported between regions and countries. Increasing expenditures in this area then are an expected corollary of development.

Farmers in Japan spend as much on pesticides as on farm implements; each accounting for 5 percent of agricultural expenditures. This general relationship between expenditures for pesticides and farm machinery may come to prevail in other densely populated, countries as they reach a comparable stage of development. (5, p. 16)

The contribution pesticides can make toward expanding output varies widely with crops and conditions. Crop failures would undoubtedly be commonplace in many places were it not for chemical pest control. In other areas, the lack of pesticides would not greatly reduce output.

Improved seeds

The term "improved seeds" can mean many things. Used in its most general sense it implies a greater production response to a given level of input. The term often means improved with respect to a specific characteristic. This may mean a stronger stem in grain to reduce lodging, a greater response to fertilizer, or earlier maturity to permit cultivation in higher latitudes. The most economic way to cope with some production problems may often be by plant

breeding, i.e., by developing an improved strain or variety. It may be less costly to develop a disease-resistant variety than to eradicate the disease.

Plant breeding and selection programs are long-term continuing programs. Useful improvements in seed are evolutionary and cumulative; they become available gradually over a long period of time. Once a breakthrough in the improvement process has been made, it may be several years before farmers learn, and become convinced of, its worth. The development of hybrid corn in the United States is a classic example of an improved seed. Advantages of hybrid corn seem obvious, yet, it required America's relatively progressive farmers several years to accept hybrid seed corn completely.

As increased reliance is placed on raising yields, improved seeds will become an even more important input. It is not possible to assess the contribution improved seeds will make in expanding world food output during the remainder of this century. This contribution will depend upon many things such as the particular crop in question, present level of yields, area of production, and extent of adoption by farmers. That improved seeds will be a key factor in future production gains, can no longer be questioned.

Mechanization

Agricultural mechanization may have two basic purposes; increasing yields or saving labor. Stated otherwise, these two goals may be described as land-saving or labor-saving. In those areas where land is the limiting factor in the production mix, mechanization usually assumes a land-saving nature. The following paragraph from an earlier publication by the author on Japanese agriculture discusses this relationship.

> "The ratio of the factors of production determines the nature of the technology adopted. In Japan, the critical ratio is the arable land-labor ratio. This ratio is most unfavorable, but little can be done to alter it; hence the technology developed has made the best use of it. The mechanization pattern of Japanese agriculture reflects a greater emphasis on increasing yields and a lesser stress on saving labor than has mechanization in most western countries . . ." (5, p. 17)

Rapid mechanization of agriculture is usually associated with a relative abundance of capital and land and a scarcity of labor. Underdeveloped regions are characterized by a scarcity of capital and land and an abundance of labor. These prevailing factor availabilities are exactly the opposite of those conducive to mechanization.

Other factors operating to restrict mechanization are the small, often noncontiguous, plots of land comprising the already small holdings of most farmers in the underdeveloped regions, especially Asia. Irrigated crops, such as rice, do not lend themselves to mechanization as readily as do upland crops. Early attempts at large-scale mechanization in underdeveloped countries have often been premature. They have also been misguided in that the emphasis was on saving labor rather than increasing yields.

In some instances farm mechanization stresses conserving labor and in others raising yields. Post-harvest mechanization, such as substituting a mechanical thresher for a flail or threshing floor, is a labor-saving innovation, and may also result in less waste than a threshing floor. The use of machines in the preplanting stage, i.e., to prepare a seedbed, is labor saving but it is also usually a yield boosting measure. The use of high pressure sprayers to apply fungicides or insecticides which could not otherwise be applied is designed to increase output rather than to save labor.

One of the most labor consuming agricultural operations in any country is the harvesting and threshing of grain. The extent to which grain harvester-thresher combines are used is therefore a useful indicator of the degree of substitution of capital for labor. North America, easily the most advanced region in this respect, had 56 percent of the world's combines in 1960 but only 15 percent of the area in grain (table 38). Asia, one of the least mechanized regions, had 1 percent of the grain combines but 42 percent of the grain area.

Mechanization has indirectly had a land-saving character because, as tractors have been substituted for draft animals, the land previously required to produce feed for draft animals can now produce food. Stated otherwise, petroleum has been substituted for feed grains and forage as the source of energy for tillage operations.

The extent to which capital has been substituted for human labor and animal power is evident in the large number of tractors in regions such as North America, Oceania and Western Europe (table 37). The developed regions have over 10 million tractors or 91 percent of the 1960 world total. This in spite of the greater area of farmland in the less developed regions. North American agriculture with 5.2 million tractors or more than 1 per farm, has reached a near saturation.

Agriculture in both Japan and the United States involves a highly developed technology. U.S. agricultural technology, however, has been designed to conserve labor, whereas, the primary aim of Japanese agriculture has been to raise yields or conserve land. The use of machinery is usually labor saving whereas fertilizer is almost always yield increasing. An examination of agricultural inputs for

Table 37.--Farm tractors, both crawler and wheel-type, by regions, average 1949-52 and annual 1960

Region	1949-52	1960
	Thousands	Thousands
Geographic regions		
North America	4,208	5,200
Latin America	131	539
Western Europe	938	3,073
E. Europe and USSR	1,089	1,460
Africa	105	218
Asia	44	217
Oceania	178	336
World	6,693	11,043
Economic regions		
Developed regions	6,413	10,069
Less developed regions	280	974
Political regions		
Free World	5,603	9,504
Communist Bloc	1,090	1,539

Source: FAO Production yearbook, 1961, (15).

1958 in the United States and Japan, where the aims of mechanization have been quite different, reflects the wide difference in emphasis.

Data for agricultural cash expenditures of Japanese farmers show 31.4 percent going for fertilizer but only 5 percent for farm implements. (5, p. 16) Major input groups in American agriculture, according to Loomis and Barton show fertilizer accounting for only 5 percent of the total as compared with 22 percent for power and machinery. (41, p. 61) These groups are not the same conceptually between countries but they do show an unquestionable difference between the composition of capital inputs and relative stress on mechanization in the two countries.

Mechanization in currently underdeveloped regions may be expected to follow the general pattern established by Japanese agriculture rather than that of North America. This would logically occur because of the much greater similarity of factor input relationships between underdeveloped countries and Japan.

Table 38.--Harvester-thresher combines, by region, 1950 and 1960

Region	1950	1960
	Thousands	Thousands
Geographic regions		
North America	[1] 900	[2] 1,207
Latin America	[3] 49	[4] 42
Western Europe	[5] 36	[6] 218
E. Europe & USSR	[7] 211	[8] 575
Africa	[9] 2	[10] 24
Asia	[11] 4	[12] 14
Oceania	[13] 60	[14] 64
World	1,262	2,144
Economic regions		
Developed regions	1,207	2,064
Less developed regions	55	80
Political regions		
Free World	1,051	1,568
Communist Bloc	211	576

[1] 1951 data used for Canada. [2] 1956 data used for Canada. [3] 1951 data used for Uruguay. Insufficient data for Ecuador and French Guiana. [4] 1955-57 data used for most countries, Brazil not incl. [5] 1952 data used for West Germany. Insufficient data for Italy and Switzerland. [6] 1955 data used for Netherlands. 1959 data used for four countries. [7] USSR only. (Other 3 countries total only 184). [8] 1959 data used for Albania. [9] Algeria and Morocco only. [10] 1955 to 1959 data used for 10 of the 16 countries. [11] Iraq, Israel and Turkey only, using 1952 data for Israel and Turkey. [12] 1958 and 1959 data used for seven of 17 countries shown. Fed. of Malaya excluded because of insufficient data. [13] 1951 data used for New Zealand. [14] Australia only. New Zealand excluded for insufficient data.

Source: FAO Production Yearbooks (15).

Chapter XI.--LOOKING AHEAD

The purpose of this look ahead is not so much to show what will occur as to show what in fact must occur if the projected numbers of people are to be fed at the assumed levels. The two projection models used might be described as exploratory rather than predictive. They are designed to give some idea of the magnitude of net grain flows between regions over the next few decades; they also provide the basis for estimating resource requirements needed to achieve certain assumed future per capita consumption levels in the less developed regions.

Underlying these projection exercises is the assumption that the United Nations "medium" population projections made in 1958 and extending to the year 2000 are reasonable. U.N. demographers projected population at three levels--low, medium, and high. At this writing population appears to be growing faster than the "medium" figures indicate but not fast enough to warrant using the "high" figures.[12] Also underlying these projections is the assumption that conventional agriculture will continue to provide the great bulk of man's food.

These projection exercises also assume that the available supply of grain per capita is a useful indicator of both the level of food intake and the pattern of consumption. This assumption is supported by the following facts and relationships: the direct consumption of grains provides just over half of man's energy intake; a substantial portion of the remaining energy intake derives from the indirect consumption of grains in the form of meat, milk, eggs, butter, and other animal fats. Further, as incomes rise and diets improve, the direct consumption of grains rises rather steadily until an acceptable level of energy intake is reached, after which, additions to the available supply of grains are converted largely to livestock products. These livestock products then make possible improvements in the nutritional quality of diets.

When attempting to assess future food production resource requirements, the use of all grains considered aggregately serves a

[12] It should be noted, however, that some demographers are now using much higher projected figures. Frank Notestein, in a recent discussion of world population trends, used a figure of 6.9 billion for the year 2000. This is substantially higher than the 6.3 billion used for the same year in this study. (60)

useful function. Grains occupy 71 percent of the world's cropland and, either directly or indirectly provide the greater part of man's food energy supply. They therefore represent a relatively uncomplicated means of linking future world food requirements with the agricultural resources needed.

The structure of the projection models is quite simple, being based on the fact that grain production minus net exports or plus net imports equals availability. Each model includes the world in terms of the same geographic, economic, and political regions used throughout this study.

Each model is presented on a regional aggregate basis and a regional per capita basis. The regional aggregate presentation permits an examination of total supply and hence resource requirements. The presentation in per capita terms makes possible close observation of shifts in per capita availability as well as the importance of net grain trade on a per capita basis.

Maintaining Current Consumption Levels in The Less Developed World (Model I)

Assumptions

The direction of per capita availability trends in the three less developed regions is uncertain, making them more difficult to project. For the purposes of this first model it is assumed that per capita availability in these regions will remain essentially constant in line with the trends over the past quarter century.

The most pronounced gains in per capita availability will occur in the middle-level income regions. In Western Europe, and to a lesser extent, Eastern Europe and the Soviet Union, diets are quite responsive to income changes and incomes are rising steadily.[13] Direct consumption of grains will not change greatly, but consumption of livestock products will rise rapidly. The requirement of something like seven pounds of grain for every pound of grainfed livestock products results in a sharply rising per capita use of grain.

Diets, and therefore per capita grain consumption, are not likely to change much in North America or Oceania, the two

[13] The higher per capita availability of grain in Eastern Europe and the Soviet Union relative to Western Europe does not indicate more livestock products in the diet (see table A-2). Rather it reflects greater dependence on animals for draft power and less favorable conditions for grazing.

regions with the highest per capita incomes.[14] Per capita grain availability is likely to rise only slightly while continuing the leveling-off trend of recent years. Further gains in per capita grain output in these two regions will be almost entirely channeled into exports.

The level of per capita net trade for each of the seven geographic regions in 1980 and 2000 reflects a continuation of the general trends prevailing over the past quarter century. It should be noted here that the projected flows of grain into the less developed regions are at a near maximum, considering the constraints imposed by inadequate port and transport facilities, the lack of well developed distribution systems, and limited consumer purchasing power. The existence of these constraints means that imports can provide only a very small part of the additional grain supplies required. Most of the additional requirements must come from expansion of indigenous output. Given the above assumptions for trends in per capita availability and trade, production becomes the dependent variable.

There are no separate assumptions for economic and political regions. Projections for these regions are derived from those for the geographic regions. The less developed regions include Asia, Africa, and Latin America; the developed regions include the remainder. The Communist Bloc includes Eastern Europe and the Soviet Union plus Communist Asia.

Calculations and Implications

Once the per capita projections by geographic regions are complete, the corresponding projections giving aggregate figures, using the population projections in Chapter Two, becomes a relatively simple matter. Proceeding from projections for the geographic regions to those for economic and political regions requires a recombination of regional data along economic and political lines. Projections for the economic and political regions then are perfectly consistent with those for geographic regions.

Under the assumptions of Model I, world grain output would expand from an annual output of 909 million tons in 1957/58-60/61 to 1,341 million tons in 1980 and 1,931 million tons in 2000. These

[14] The relatively low per capita availability of grains in Oceania compared with the other developed regions should not be considered indicative of inadequate diets as is generally the case. Diets in Australia and New Zealand compare favorably with those of the United States and Canada (see table A-2). Grain utilization is low because the extensive livestock industry of this region is largely grass-based, livestock consuming little grain.

Table 39.--Model I: Per capita annual grain production, net trade, and availability, by regions, selected periods 1934-60 and projections to 1980 and 2000.[1]

Item	1934-38	1948-52	1957/58-60/61	1980	2000
	Kilograms				
Geographic regions					
North America					
Production	768	1,006	1,057	1,120	1,200
Net trade	-37	-139	-174	-230	-300
Availability	731	867	883	890	900
Latin America					
Production	254	190	211	202	196
Net trade	-74	-5	-4	+5	+11
Availability	180	185	207	207	207
Western Europe					
Production	247	234	286	370	420
Net trade	+88	+79	+78	+80	+80
Availability	335	313	364	450	500
E. Europe & USSR					
Production	533	453	541	571	617
Net trade	-16	NA	+1	+4	+8
Availability	517	NA	542	575	625
Africa					
Production	158	161	165	161	159
Net trade	-4	+2	+6	+10	+12
Availability	154	163	171	171	171
Asia					
Production	231	197	223	218	216
Net trade	-2	+4	+7	+12	+14
Availability	229	201	230	230	230
Oceania					
Production	455	538	533	600	710
Net trade	-252	-265	-239	-300	-400
Availability	203	273	294	300	310
Economic regions					
Developed regions					
Production	470	497	568	636	696
Net trade	+15	-5	-18	-33	-53
Availability	485	492	550	603	643
Less developed regions					
Production	224	192	215	211	208
Net trade	-8	+2	+7	+11	+14
Availability	216	194	222	222	222
Political regions					
Free World					
Production	278	275	306	306	295
Net trade	+2	+1	-2	-4	-5
Availability	280	276	304	302	290
Communist Bloc[2]					
Production	359	301	345	341	334
Net trade	-4	-1	+3	+7	+9
Availability	355	300	348	348	343

[1] Plus sign = net imports; Minus sign = net exports.
[2] Cuba not included.

Source: Data through 1960/61 based on earlier tables.

projections show total grain output in all three less developed regions considered aggregately, increasing 53 percent and 139 percent beyond present levels by 1980 and 2000 respectively. This compares with 43 and 88 percent for the developed regions. Historically, output has expanded faster in the developed than in the

Table 40.--Model I: Total annual grain production, net trade and availability, by regions, selected periods 1934-60 and projections to 1980 and 2000.[1]

Item	1934-38	1948-52	1957/58-60/61	1980	2000
	Million metric tons				
Geographic regions					
North America					
Production	109	169	204	284	375
Net trade	-5	-23	-34	-58	-94
Availability	104	146	170	226	281
Latin America					
Production	31	31	42	70	116
Net trade	-9	-1	-1	+2	+7
Availability	22	30	41	72	123
Western Europe					
Production	67	65	85	130	176
Net trade	+24	+22	+23	+28	+34
Availability	91	87	108	158	210
E. Europe & USSR					
Production	153	134	180	251	325
Net trade	-5	NA	(2)	+2	+4
Availability	148	NA	180	253	329
Africa					
Production	26	32	38	54	82
Net trade	-1	(2)	+1	+3	+6
Availability	25	32	39	57	88
Asia					
Production	260	272	353	538	836
net trade	-2	+6	+12	+30	+54
Availability	258	278	365	568	890
Oceania					
Production	5	7	8	14	21
Net trade	-3	-3	-4	-7	-12
Availability	2	4	4	7	9
Economic regions					
Developed regions					
Production	334	375	476	679	897
Net trade[3]	+11	-4	-15	-35	-68
Availability	345	371	461	644	829
Less developed regions					
Production	316	334	433	662	1,034
Net trade[3]	-11	+4	+15	+35	+68
Availability	305	338	448	697	1,102
Political regions					
Free World					
Production	384	452	574	850	1,232
Net trade[3]	+3	+1	-3	-10	-19
Availability	387	453	571	840	1,213
Communist Bloc[4]					
Production	266	257	336	491	698
Net trade[3]	-3	[5] -1	[5] +3	+10	+19
Availability	263	256	339	501	717

[1] Plus sign = net imports; minus sign = net exports. [2] Negative but less than 500,000 metric tons. [3] Net trade for economic regions may not equal total of geographic regions due to rounding. [4] Cuba not included. [5] Although complete data on net trade for the Bloc countries are not available for this period, net imports are assumed equal to the net exports of the Free World.

less developed regions. But the rate of increase in the less developed regions must surpass that of the developed regions by a considerable margin over the next four decades if current, nutritionally inadequate per capita availability levels in the less developed regions are to be merely maintained!

Achieving Modest Consumption Gains in The Less Developed Regions (Model II)

Assumptions

Model II differs from Model I only in that the assumptions of per capita availability for the three less developed regions of Asia, Africa, and Latin America are changed. Model I was based on the assumption that future per capita availability in these three regions would remain essentially unchanged, as was the case over the last quarter century. Model II, however, assumes that per capita availability in each of the less developed regions will increase 10 percent by 1980 and an additional 10 percent by 2000. These percentages are applied to the 1957/58-60/61 base period. Increases in availability are assumed to come about through expanded production. Assumed trade levels are the same in both Models for all regions.

Calculations and Implications

As stated earlier, Model II differs from Model I only in that it assumes some improvement in per capita availability in each of the three less developed regions--10 percent by 1980 and 20 percent by 2000. This increase is to come from growth in indigenous per capita output; per capita trade levels are the same in both Models (fig. 26). Under this assumption availability goes from an average of 222 kilograms per year in the less developed world at present to 243 in 1980 and 265 in the year 2000. This compares with an average of 550 kilograms at present in the developed countries.

The per capita annual availability of grain in North America is currently 883 kilograms, or 661 kilograms higher than the 222 kilograms in the less developed regions. Under the assumptions of Model II, the per capita availability in North America will rise to 900 kilograms, so the difference will be reduced only from 661 kilograms at present to 635 kilograms by the end of the century.

Of the assumed gains in annual per capita grain availability in the less developed regions of 43 kilograms, it is likely that part will be consumed directly and part converted into livestock products. If half of the increase of 43 kilograms were consumed directly and half were converted into livestock products, the gain in livestock product consumption would be about three kilograms per person per year. This is indeed a modest gain!

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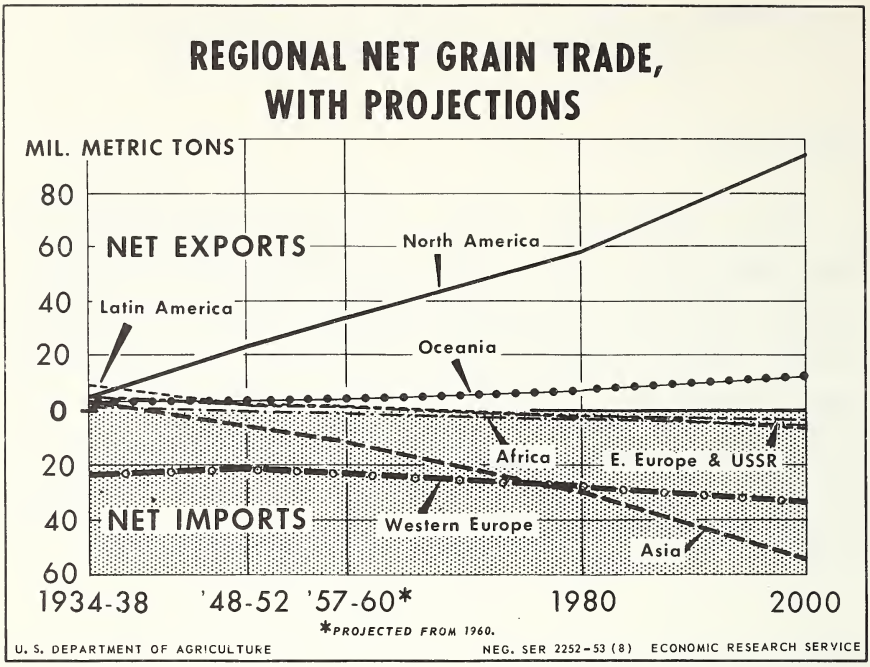

Figure 26

Model II, assuming modest per capita increases in availability and production for the less developed regions, projects world grain output at 1,411 million tons in 1980 and 2,150 million tons by 2000. These figures represent an increase over the annual average output of 909 million tons in 1957/58-60/61 of 55 percent in 1980 and 137 in 2000. Percentage gains for the developed world in 1980 and 2000 are 43 and 88 percent respectively. Corresponding figures for the less developed world are 69 and 189 percent. Total grain output in the less developed world must nearly triple within the next four decades if even the extremely modest assumed gains in per capita availability for the rapidly growing populations are to be maintained; stated otherwise, the addition to output must closely approximate current world output. This must be done in less than four decades and with limited resources.

Projected Resource Requirements

The land, labor, and capital resources required to meet projected output levels in the developed regions should continue to be more than adequate for the remainder of this century. Such is not

Table 41.--Model II: Per capita annual grain production, net trade and availability, by regions, selected periods 1934-60 and projections to 1980 and 2000.[1]

Item	1934-38	1948-52	1957/58-1960/61	1980	2000
			Kilograms		
Geographic regions					
North America					
Production	768	1,006	1,057	1,120	1,200
Net trade	-37	-139	-174	-230	-300
Availability	731	867	883	890	900
Latin America					
Production	254	190	211	223	237
Net trade	-74	-5	-4	+5	+11
Availability	180	185	207	228	248
Western Europe					
Production	247	234	286	370	420
Net trade	+88	+79	+78	+80	+80
Availability	335	313	364	450	500
E. Europe and USSR					
Production	533	453	541	571	617
Net trade	-16	n.a.	+1	+4	+8
Availability	517	n.a.	542	575	625
Africa					
Production	158	161	165	178	193
Net trade	-4	+2	+6	+10	+12
Availability	154	163	171	188	205
Asia					
Production	231	197	223	241	262
Net trade	-2	+4	+7	+12	+14
Availability	229	201	230	253	276
Oceania					
Production	455	538	533	600	710
Net trade	-252	-265	-239	-300	-400
Availability	203	273	294	300	310
Economic regions					
Developed regions					
Production	470	497	568	636	697
Net trade	+15	-5	-18	-33	-53
Availability	485	492	550	603	644
Less developed regions					
Production	224	192	215	232	251
Net trade	-8	+2	+7	+11	+14
Availability	216	194	222	243	265
Political regions					
Free World					
Production	278	275	306	323	329
Net trade	+2	+1	-2	-4	-5
Availability	280	276	304	319	324
Communist Bloc					
Production	359	301	345	358	371
Net trade	-4	-1	+3	+7	+9
Availability	355	300	348	365	380

[1] Plus sign = net imports; minus sign = net exports.

Source: Data through 1960/61 from earlier tables.

the case, however, for the less developed regions. Both Latin America and Africa will continue to suffer from shortages of agricultural capital; Asia will be faced with extreme shortages of both land and capital.

To use Model I to calculate the requirements of land or capital for the less developed regions, however, is not warranted here

Table 42.--Model II: Total annual grain production, net trade, and availability, by regions, selected periods 1934-60 and projections to 1980 and 2000[1]

Item	1934-38	1948-52	1957/58-60/61	1980	2000
	Million metric tons				
Geographic regions					
North America					
Production	109	169	204	284	375
Net trade	-5	-23	-34	-58	-94
Availability	104	146	170	226	281
Latin America					
Production	31	31	42	77	140
Net trade	-9	-1	-1	+2	+7
Availability	22	30	41	79	147
Western Europe					
Production	67	65	85	130	176
Net trade	+24	+22	+23	+28	+34
Availability	91	87	108	158	210
E. Europe and USSR					
Production	153	134	180	251	325
Net trade	-5	NA	(2)	+2	+4
Availability	148	NA	180	253	329
Africa					
Production	26	32	38	60	100
Net trade	-1	(2)	+1	+3	+6
Availability	25	32	39	63	106
Asia					
Production	260	272	353	595	1,014
Net trade	-2	+6	+12	+30	+54
Availability	258	278	365	625	1,068
Oceania					
Production	5	7	8	14	21
Net trade	-3	-3	-4	-7	-12
Availability	2	4	4	7	9
Economic regions					
Developed regions					
Production	334	375	476	679	897
Net trade[3]	+11	-4	-15	-35	-68
Availability	345	371	461	644	829
Less developed regions					
Production	316	334	433	732	1,253
Net trade[3]	-11	+4	+15	+35	+68
Availability	305	338	448	767	1,321
Political regions					
Free World					
Production	384	452	574	896	1,374
Net trade	+3	+1	-3	-10	-19
Availability	387	453	571	886	1,355
Communist Bloc[4]					
Production	266	257	336	515	776
Net trade	-3	[5] -1	[5] +3	+10	+19
Availability	263	256	339	525	795

[1] Plus sign = net imports; minus sign = net exports. [2] Negative but less than 500,000 metric tons. [3] Net trade for economic regions may not equal total of geographic regions due to rounding. [4] Cuba not included. [5] Although complete data on net trade for the Bloc countries are not available for this period, net imports are assumed equal to the net exports of the Free World.

Source: Data through 1960/61 from earlier tables.

because the assumption of static per capita consumption levels over the next four decades is not an acceptable one. This assumption is unacceptable from a nutritional point of view and therefore also unacceptable in both social and political terms. For a discussion

of this see Chapter IV. The discussion of resource requirements will therefore be based on the projections in Model II where it is assumed that per capita consumption levels will improve slightly in the less developed regions as a result of modest gains in per capita income.

In discussing resource requirements labor will not be included because it is not now in short supply, and, given the population projections for the underdeveloped world, it is not expected to be a limiting factor during the period under projection. General estimates based on past trends will be provided for the relative shares of the projected growth in grain output expected to derive from additional acreage (land) and from higher yields (reflecting largely additional capital inputs) for each region.

Where capital inputs are concerned, only fertilizer will be discussed. The reason for this is twofold. First, it is probably the most important capital input and secondly, it is easier to discuss on an aggregate basis because more is known about crop response to fertilizer than to other, less easily measured, more variable inputs such as pesticides and improved seeds.

Two things then, population growth and the assumed modest increases in per capita grain consumption, will combine to increase aggregate demands. Most of this growing demand can be satisfied only by indigenous production; imports can contribute only a very small fraction of the total increase. These projections provide for growing net grain imports into the underdeveloped world, going from the 15 million ton annual average of 1957/58-60/61 to 35 million tons in 1980 and 68 million in 2000. Net imports now account for just over three percent of total grain consumption in the less developed regions. Although net imports are expected to multiply five times above present levels by 2000, they will still supply only five percent of grain consumption. Large though these quantities may seem to the net exporting regions of North America and Oceania, they are quite small in relation to the projected needs of the less developed world.

Indigenous production, then, must provide the great bulk of the additional requirements. For Asia, this means expanding grain output 69 percent above the present level by 1980 and 187 percent above the present level by 2000. If projected needs are to be met, regional grain output must increase at the rate of 12 million tons per year between now and 1980 and 20 million tons per year from 1980 to 2000 (fig. 27). This greater output may be achieved by expanding the cultivated area, by raising yields, or by some combination of the two. Historical trends in world grain output, planted area and yields show that over the last decade, one-fifth of the growth in output came from expanding the planted area and four-fifths from raising yields.

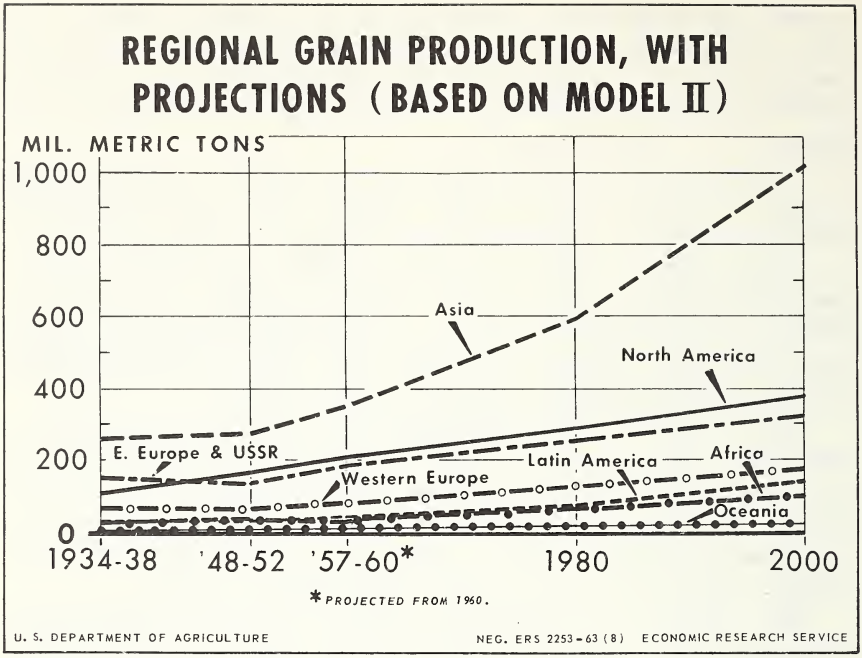

Figure 27

Prior to World War II, additional grain output in Asia occurred largely as a result of expanding the area under cultivation. In recent years, however, yields have become relatively more important, accounting for two thirds of output gains over the past decade. During the remaining decades of this century at least four fifths of the gains in output must come from increasing output per acre.

Given this information, it now becomes possible to examine annual required increases in yields. Yields must increase well over 50 percent above present levels by 1980 and 150 percent by 2000. This means yields must rise two to three percent annually above 1957-60 levels between now and 1980 and about five percent on an average annual basis between 1980 and 2000. Stated otherwise, grain yields for Asia as a whole would have to reach, by the end of the century, a level nearly 80 percent of the present Japanese level.

As long as output is expanded by the conventional route of expanding the cultivated area, capital requirements are minimal. But when it becomes necessary suddenly to look to rising yields to secure most of the additional output, capital inputs must climb

rapidly. The next few paragraphs will be devoted to developing some estimates of future requirements of the principal capital input--fertilizer--in Asia. It is assumed that the amount of fertilizer required to achieve a unit of additional output on new, often marginal, land will be comparable to that required on the existing cultivated area. The ten to one grain/fertilizer response ratio will thus be applied to all output gains whether from increasing yields or bringing new land under cultivation.

Many things, such as rainfall, temperature, soils, irrigation, tillage practices, plant protection and weed control measures, and the varying responsiveness of individual grains and varieties of grains influence grain output per unit of fertilizer input. Also, after a point, as fertilizer inputs increase, returns per additional unit of fertilizer are likely to diminish. Given the present very low fertilizer application rates of only five kilograms per acre in Asia (table 35), however, diminishing returns will not soon be a problem.

Both farm practice and data from experimental plots indicate a responsiveness to output of about 10 kilograms of grain per kilogram of chemical fertilizer plant nutrients applied. (30 p. 243; 35 p. 116; 50 p. 16) This ratio then will be used to estimate future chemical fertilizer needs, assuming that other required farm practices will be applied with the fertilizer, including good seeds and adequate water availability to make the added plant nutrients effective. As to type of fertilizer, i.e., N, P_2O_5, or K_2O, it may be observed that world consumption of chemical fertilizer in 1960/61 amounted to 28.6 million metric tons of plant nutrients, of which 35 percent was N, 35 percent was P_2O_5, and 30 percent was K_2O. Asia consumed about 3.3 million tons of chemical fertilizer plant nutrients in 1960/61. About one-half of this was N, one-fourth P_2O_5, and one-fourth K_2O.

Given the above ten-to-one rule of thumb, and the projected increase in grain requirements of 242 million tons by 1980, Asia's annual fertilizer consumption would need to increase by about 24 million tons of plant nutrients or to a total of 27 million tons by 1980 (fig. 28). This figure of 27 million tons closely approximates the current world consumption of 28.6 million tons. By the year 2000, grain requirements will need to increase 669 million tons above the present production of 353 million metric tons. This would mean fertilizer requirements would increase by 67 million tons or to a total of 70 million tons.

If the land area used to produce grains were to increase 20 percent above the present acreage during the projection period, i.e., to a total of about 800 million acres by the year 2000, the average fertilizer application rate would be 90 kilograms per acre, or about four-fifths of the present rate of application in Japan. Very large

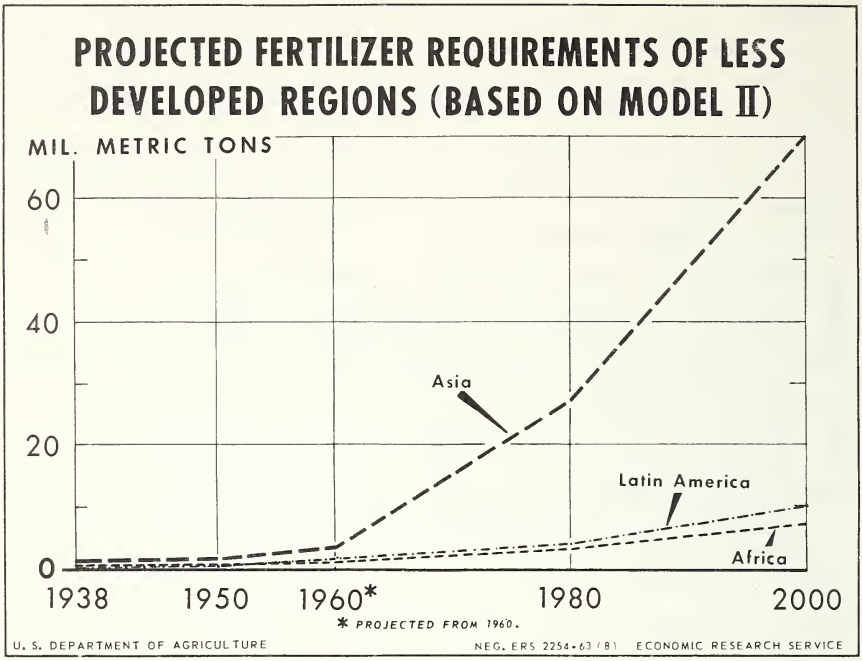

Figure 28

areas in Asia have low rainfall and do not lend themselves to irrigation. Because of this, it may be very difficult to match the high yields of Japan throughout Asia, even with the best of farm practices.

Africa seems to be much more fortunate than Asia with respect to land resources. The expansion in grain output over the past quarter century has derived almost equally from additions to the planted area and from rising yields. It is not likely that this situation will continue, but it may be possible to get as much as one-third of the projected additional grain requirements by adding more land. This would leave two-thirds to be attained by rising yields. Yields would have to increase at an average rate of nearly two percent annually until 1980 and between three and four percent from then until the end of the century. Annual regional grain output is projected to increase 22 million tons by 1980 and a total of 62 million tons by 2000 reaching a total output of 100 million tons. If the fertilizer response coefficient of 10 pounds of grain per pound of fertilizer applies in Africa, the current fertilizer usage of 0.7 million tons must rise to 2.7 million tons by 1980 and 6.7 million tons by 2000.

Latin America is the only region in which additions to the cultivated area have been more important than rising yields as a source of increasing grain output over the last few decades. Expansion of the planted area has accounted for about four-fifths of the growth in grain output. It is likely that yields will become more important in future years, and that only about half of the expansion in output between now and the end of the century will be achieved by expanding the planted area. If our assumptions underlying Model II are not unreasonable, Latin American grain output will increase 71 percent or 30 million tons by 1980 and 212 percent or 89 million tons by the year 2000. Applying the rule of thumb again, we see that the present regional fertilizer consumption of one million metric tons will need to increase to four million tons by 1980 and ten million tons by 2000.

Total fertilizer consumption in the underdeveloped world is currently five million tons per year. If our ten to one ratio is reasonable and if per capita grain availability in the underdeveloped world increases ten percent by 1980 and an additional 10 percent by 2000, fertilizer requirements should reach 34 million tons by 1980 and 87 million tons by 2000.

Chapter XII.--CONCLUSIONS

Many conclusions have been reached as a result of this empirical-historical approach to analyzing and projecting the world food problem. All of these, however, tend to support two broad conclusions. These are:

(1) The effort required by the less developed regions to feed, at assumedly modest levels, their projected populations for the four remaining decades of this century will severely tax their resources.

(2) The role of the U.S. agricultural sector, as a source of food, capital and technical assistance for the food-scarce, less developed regions, is growing steadily, promising to achieve an importance without precedent.

The following rather independent conclusions reached in the various sections of this study all provide support for the two general conclusions stated above.

(1) Contrary to popular opinion concerning the similar demographic stages through which all countries pass, the currently developed world has never experienced a rate of natural increase comparable to that now facing the underdeveloped world. The highest decade rate of growth registered this century by the developed world was 12.8 percent, while the decade rate for the underdeveloped world is now 22.4 percent and still rising.

(2) Arable land per capita is declining in every region.

(3) The direct consumption of grains provides 53 percent of man's food energy supply. A large part of the remainder is supplied by the indirect consumption of grain in the form of livestock products such as meat, milk, eggs, and animal fats.

(4) Per capita grain production in the less developed world is now lower than it was before World War II.

(5) North America was the major net exporter of every grain considered individually except rice, as well as all grains considered aggregately in 1960/61.

(6) North America is emerging as the breadbasket of the world. Prewar net grain exports were 5 million tons or 22 percent of the world total of net regional exports. In 1960/61, net regional exports were 39 million tons or 86 percent of the world total. Present trends indicate net exports of 58 million tons in 1980 and 94 million tons by 2000.

(7) Trends in food trade show that the less developed world is steadily losing the capacity to feed itself.

(8) The rapid population growth characteristic of the rice consuming regions, coupled with the concentration of food production potential in the wheat growing regions, will result in the gradual substitution of wheat for rice in many countries.

(9) The productivity of both agricultural land and labor varies widely between major geographic regions. Variations in labor productivity are, however, several times greater than variations in land productivity. Average regional grain yields vary from 318 kilograms per acre in Africa to 927 kilograms in North America. Annual grain output per person in the farm population, however, varies from 294 kilograms in Africa to 9,909 kilograms in North America.

(10) Densely populated, low-income countries face the possibility of being trapped permanently at low income levels. Historically, population was in equilibrium, but with the widespread improvements in health, sanitation and disease eradication occurring in recent decades, population began to grow in a rapid, uninterrupted fashion. The cultivated area has traditionally expanded apace with population but the supply of readily reclaimable land is now nearly exhausted. This diminution of the easily reclaimable land supply while still at the subsistence level, has created a low income trap. With the amount of land which can be brought into cultivation restricted by the increasing costs of making new land productive and the limited capital available, yields must be raised to meet the needs of population growth. Raising yields requires capital. If incomes are still at the subsistence level, the needed capital is not forthcoming and countries become dependent on external sources of food, capital or both.

(11) Agricultural technology has been developed almost entirely in the temperate regions and, unlike industrial technology, it cannot always be readily transferred to the less developed regions, situated largely in the tropical and subtropical regions. With proper adaptation, however, many of the basic practices and institutions contributing to high agricultural productivity in North America can be transferred to the less developed regions.

(12) The real cost per unit of food output is much higher in densely populated countries than in countries with relatively high land/man ratios.

(13) Agricultural production potential is now concentrated in North America. Production potential is determined largely by the availability of land and capital, the level of agricultural technology and the nature of institutions. Institutions must be such as to closely link effort and reward. To the extent that they fail to do this production potential is reduced. All the less developed regions lack capital, an advanced agricultural technology, and the requisite institutions. Asia lacks land as well. Given the rather favorable arable land-man ratio in Latin America and Africa, the food outlook could improve considerably if the limitations discussed above were reduced. The Soviet Bloc is reasonably well situated with respect to land, capital, and technology, but the inability of existing institutions to link effort and reward seriously limits food production potential. Western Europe has everything except land; its per capita land endowment is the lowest of any region. Oceania possesses all the requisites but on a very small scale, having only 1 percent of the world's cropland. Its role in the world economy will necessarily be limited. North American agriculture alone possesses all the requisites on a large scale. Although the amount of food moving from North America to the less developed regions will be much larger in the future than at present, it will not represent more than a very small part of the projected increase in requirements.

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APPENDIX

Table A1.--Land utilization pattern, by regions, 1959

Regions	Arable land and land under tree crops	Permanent meadows and pastures	All other land	Total land
	Percent			
Geographic regions				
North America	11.8	14.4	73.8	100.0
Latin America	5.0	18.0	77.0	100.0
Western Europe	26.8	15.5	57.7	100.0
E. Europe and USSR	11.7	16.5	71.8	100.0
Africa	7.8	19.6	72.6	100.0
Asia	16.0	16.0	68.0	100.0
Oceania	3.3	52.3	44.4	100.0
World average	10.6	19.3	70.1	100.0
Economic regions				
Developed regions	11.5	21.2	67.3	100.0
Less developed regions	9.9	17.9	72.2	100.0
Political regions				
Free World	10.2	20.1	69.7	100.0
Communist Bloc	11.6	17.0	71.4	100.0

Source: FAO Production yearbook, 1960 (15).

Table A2.--Percentage distribution of total calorie supply by major food groups, by countries, 1958

Country	Grain products, roots, and tubers	Fruits, nuts, and vegetables	Sugar	Fats and oils	Livestock products	Fish	Total
	Percent						
North America							
Canada	25.8	7.2	16.2	15.1	35.7	--	100.0
United States	24.2	9.3	15.8	20.4	30.1	.2	100.0
Latin America							
Argentina	43.8	4.3	11.6	10.9	29.3	.1	100.0
Bolivia	59.5	10.6	12.8	4.5	12.3	.3	100.0
Brazil	51.8	13.8	15.2	6.9	12.1	.2	100.0
Chile	56.7	7.0	11.7	9.4	13.9	1.3	100.0
Colombia	42.2	17.4	19.6	6.7	13.9	.2	100.0
Costa Rica	36.6	18.4	20.0	10.9	13.9	.2	100.0
Cuba	49.5	6.6	14.8	12.7	16.2	.2	100.0
Dominican Rep.	41.0	24.4	14.6	10.8	8.7	.5	100.0
Ecuador	45.8	24.1	14.7	6.7	8.2	.5	100.0
El Salvador	57.5	16.2	12.4	5.8	8.1	--	100.0
Guatemala	59.5	15.6	13.8	4.6	6.5	--	100.0
Haiti	55.2	26.2	10.1	4.0	4.2	.3	100.0
Honduras	67.4	12.6	10.3	3.4	6.1	.2	100.0
Mexico	55.4	12.3	12.5	8.4	11.2	.2	100.0
Nicaragua	47.4	12.6	22.1	3.5	14.1	.3	100.0
Panama	52.8	15.6	12.0	6.8	12.6	.2	100.0
Paraguay	54.8	7.5	10.0	5.5	22.2	--	100.0
Peru	55.7	13.2	14.2	5.9	10.0	1.0	100.0
Uruguay	39.6	3.7	11.2	12.7	32.8	--	100.0
Venezuela	42.2	22.4	14.2	8.0	13.2	--	100.0
Western Europe							
Austria	43.3	4.6	12.0	15.9	24.0	.2	100.0
Belgium	42.5	5.4	11.0	18.6	21.6	.9	100.0
Denmark	32.3	4.5	16.7	17.8	27.5	1.2	100.0
Finland	42.6	2.1	13.2	16.2	25.1	.8	100.0
France	45.5	5.5	10.1	14.8	23.4	.7	100.0
Germany, West	40.3	4.7	10.3	20.8	23.2	.7	100.0
Greece	57.9	12.1	4.8	15.3	9.0	.9	100.0
Ireland	47.5	2.8	13.0	13.3	23.1	.3	100.0
Italy	58.3	9.3	6.6	13.4	11.8	.6	100.0
Netherlands	35.9	4.3	15.0	22.9	21.3	.6	100.0
Norway	34.6	4.4	12.9	20.4	25.4	2.3	100.0
Portugal	56.0	11.2	6.6	16.6	7.2	2.4	100.0
Spain	54.3	10.7	5.9	16.1	11.6	1.4	100.0
Sweden	32.7	4.5	15.5	17.5	28.6	1.2	100.0
Switzerland	37.6	6.5	14.0	13.8	27.9	.2	100.0
United Kingdom	32.0	5.1	18.0	17.0	26.9	1.0	100.0
E. Europe & USSR							
Bulgaria	74.4	6.3	3.3	7.9	8.1	--	100.0
Czechoslovakia	52.1	3.9	12.3	12.1	19.3	.3	100.0
Germany, East	50.7	3.1	8.4	15.9	21.2	.7	100.0
Hungary	57.7	5.1	8.8	13.4	15.0	(1)	100.0
Poland	58.8	2.8	9.3	10.2	18.6	.3	100.0
Rumania	72.8	4.3	4.3	9.1	9.3	.2	100.0
Yugoslavia	67.3	6.0	5.1	9.4	12.2	(1)	100.0
USSR	67.0	3.2	8.1	8.1	13.1	.5	100.0
Africa							
Algeria	65.2	7.9	9.4	6.5	10.5	.5	100.0
Angola	67.5	16.0	3.4	8.6	3.8	.7	100.0
Belgian Congo & Ruanda-Urundi	66.6	23.6	.6	7.0	1.3	.9	100.0
Cameroun	72.1	15.8	.6	9.7	1.0	.8	100.0
Egypt	68.9	12.2	4.7	9.2	4.6	.4	100.0
Ethiopia	67.1	8.7	1.1	5.5	17.2	.4	100.0
Fed. of Rhoesia & Nyasaland	75.4	12.4	4.0	1.0	7.0	.2	100.0

Table A2.--Percentage distribution of total calorie supply by major food groups, by countries, 1958--Continued

Country	Grain products, roots, and tubers	Fruits, nuts and vegetables	Sugar	Fats and oils	Livestock products	Fish	Total
	Percent						
Africa--Cont.							
Fr. Equat. Africa	69.5	14.7	1.2	10.9	3.3	.4	100.0
Fr. West Africa..	80.9	9.0	2.4	5.5	1.8	.4	100.0
Ghana.....	69.1	13.2	3.2	10.6	3.1	.8	100.0
Guinea.....	71.5	12.9	1.3	12.5	1.4	.4	100.0
Kenya.....	78.4	6.3	4.2	3.3	7.8	--	100.0
Liberia.....	75.1	7.1	1.6	14.8	1.0	.4	100.0
Libya.....	53.7	23.2	8.0	9.6	5.0	.5	100.0
Morocco.....	63.9	5.2	13.7	6.3	10.5	.4	100.0
Nigeria.....	77.0	10.5	1.1	9.3	1.7	.4	100.0
Sudan.....	63.0	9.2	5.2	11.1	11.1	.4	100.0
Tanganyika.....	68.1	22.3	3.2	.9	5.5	--	100.0
Togoland.....	74.8	11.9	.8	10.8	1.3	.4	100.0
Tunisia.....	65.0	8.8	9.7	6.0	9.8	.7	100.0
Un. of S. Africa.	59.5	3.2	13.0	8.2	15.3	.8	100.0
Asia							
Burma.....	76.2	8.6	4.7	4.9	3.5	2.1	100.0
Ceylon.....	61.1	21.9	5.6	7.0	2.9	1.5	100.0
India.....	68.0	15.0	6.3	6.3	3.9	.5	100.0
Indonesia.....	68.7	17.9	5.4	6.1	1.2	.7	100.0
Iran.....	65.9	10.1	8.6	5.6	9.8	[1]	100.0
Iraq.....	66.1	9.3	8.9	6.0	9.5	.2	100.0
Israel.....	47.3	10.7	11.1	16.4	13.6	.9	100.0
Japan.....	74.9	8.5	6.7	4.1	2.8	3.0	100.0
Jordan.....	63.5	14.1	7.4	8.9	6.1	[1]	100.0
Korea, South.....	85.3	5.9	6.7	4.1	2.8	3.2	100.0
Lebanon.....	68.2	7.3	7.2	8.3	8.8	.2	100.0
Malaya, Fed. of..	65.3	12.2	7.2	7.6	6.2	1.5	100.0
Pakistan.....	73.7	11.8	8.9	2.2	2.7	.7	100.0
Philippines.....	66.1	16.1	6.5	4.7	4.7	1.9	100.0
Singapore.....	51.3	14.5	5.7	13.1	13.5	1.9	100.0
Syria.....	65.2	12.6	6.3	6.7	9.2	[2]	100.0
Taiwan.....	73.0	9.0	5.8	4.1	6.6	1.5	100.0
Thailand.....	66.4	13.0	3.9	5.7	4.8	6.2	100.0
Turkey.....	72.0	9.4	5.1	7.7	5.6	.2	100.0
Communist Asia.....	80.7	8.9	1.1	5.0	3.6	.7	100.0
Oceania							
Australia.....	30.8	5.5	16.6	12.3	34.2	.6	100.0
New Zealand.....	27.0	5.9	14.8	12.5	39.5	.3	100.0

[1] Negligible
[2] Less than .05 percent

Source: U.S. Dept. Agr. Food Balances in Foreign Countries (19, 20, 21, 22).

Table A3.--Percentage of diet supplied by principal staple, by countries, 1958

Country	Staple	Percent staple of total calories	Country	Staple	Percent staple of total calories
North America			Africa		
Canada	Wheat	19.1	Algeria	Wheat	44.4
United States	Wheat	17.6	Angola	Corn	29.6
			Belgian Congo and Ruanda-Urundi	Cassava	46.6
Latin America					
Argentina	Wheat	33.2	Cameroun	Cassava	20.8
Bolivia	Corn	22.3	Egypt	Wheat	34.6
Brazil	Cassava	16.3	Ethiopia	Teff[3]	51.9
Chile	Wheat	43.1	Fed. of Rhodesia and Nyasaland	Corn	53.6
Colombia	Corn	20.7			
Costa Rica[1]	Corn	12.7	Fr. Equat. Africa	Sorghum & millet	34.4
Cuba	Rice	19.2			
Dominican Republic[1]	Bananas & Plaintains	13.9	Fr. West Africa	Sorghum & millet	40.4
Ecuador	Corn	15.2	Ghana	Potatoes[4]	20.3
El Salvador	Corn	29.9	Guinea	Rice	28.3
Guatemala	Corn	49.9	Kenya	Corn	57.4
Haiti	Cassava	14.1	Liberia	Rice	33.5
Honduras	Corn	47.7	Libya	Wheat	24.0
Mexico	Corn	45.9	Morocco	Wheat	28.4
Nicaragua	Corn	35.0	Nigeria	Potatoes[4]	28.0
Panama	Rice	21.3	Sudan	Sorghum & millet	55.3
Paraguay	Cassava	22.7			
Peru	Wheat	16.2	Tanganyika	Sorghum & millet	36.1
Uruguay	Wheat	31.2			
Venezuela	Corn	15.5	Togoland	Cassava	22.1
			Tunisia	Wheat	45.9
Western Europe			Rep. of S. Africa	Corn	36.3
Austria	Wheat	21.9			
Belgium	Wheat	29.7	Asia		
Denmark	Wheat	13.7	Burma	Rice	73.7
Finland	Wheat	20.6	Ceylon	Rice	44.4
France	Wheat	35.5	Communist Asia	Rice	50.9
Greece	Wheat	50.8	India	Rice	33.4
Ireland	Wheat	34.1	Indonesia	Rice	41.9
Italy	Wheat	46.1	Iran	Wheat	52.2
Netherlands	Wheat	25.6	Iraq	Wheat	47.7
Norway	Wheat	21.9	Israel	Wheat	41.8
Portugal	Wheat	23.3	Japan	Rice	49.4
Spain	Wheat	41.3	Jordan	Wheat	52.0
Sweden	Wheat	18.4	Korea, South	Rice	47.3
Switzerland	Wheat	27.8	Lebanon	Wheat	59.8
United Kingdom	Wheat	24.7	Malaya, Fed. of	Rice	54.4
			Pakistan	Rice	47.0
E. Europe and USSR			Philippines	Rice	42.0
Bulgaria	Wheat[2]	60.7	Syria	Wheat	51.9
Czechoslovakia	Wheat[2]	44.1	Taiwan	Rice	56.0
East Germany	Wheat[2]	36.6	Thailand	Rice	65.0
Hungary	Wheat[2]	47.9	Turkey	Wheat	56.4
Poland	Wheat[2]	44.7			
Rumania	Wheat[2]	38.0	Oceania		
USSR	Wheat	40.5	Australia	Wheat	26.1
Yugoslavia	Wheat[2]	47.3	New Zealand	Wheat	23.1

[1] Sugar actually supplies more calories than any other food in the Costa Rican and Dominican diets but, not being usually conceived of as a staple, it is not included here.
[2] Includes rye.
[3] Mostly teff, a grass producing a very small edible seed. It is not widely cultivated anywhere in the world except Ethiopia.
[4] Includes both white and sweetpotatoes, yams and cocoa yams.

Source: U. S. Dept. Agri. Food Balances in Foreign Countries (19, 20, 21, 22).

Table A4.--Food consumption levels per person per day, in terms of calories, protein, and fat content, by countries, 1958

Country	Calories	Protein				Fat
		Animal	Pulse	Other	Total	
	Number	Grams	Grams	Grams	Grams	Grams
North America						
Canada	3,080	62	2	30	94	138
United States	3,220	66	5	26	97	149
Latin America						
Argentina	3,360	62	1	37	100	121
Bolivia	1,880	14	4	32	50	28
Brazil	2,815	20	14	30	64	56
Chile	2,610	27	6	38	71	61
Colombia	2,225	20	3	28	51	43
Costa Rica	2,555	23	8	28	59	61
Cuba	2,870	28	9	31	68	69
Dominican Republic	1,950	12	5	20	37	45
Ecuador	1,935	10	7	28	45	32
El Salvador	1,975	12	13	32	57	38
Guatemala	2,175	9	9	37	55	38
Haiti	1,875	4	13	25	42	22
Honduras	2,190	9	8	41	58	33
Mexico	2,725	18	10	41	69	59
Nicaragua	1,985	18	5	27	50	38
Panama	2,370	19	6	32	57	51
Paraguay	2,335	35	7	28	70	60
Peru	2,040	13	6	33	52	34
Uruguay	2,945	59	1	50	110	118
Venezuela	2,255	18	9	29	56	48
Western Europe						
Austria	3,010	41	1	33	75	109
Belgium	2,890	42	1	33	76	112
Denmark	3,255	55	1	32	88	139
Finland	3,110	46	1	37	84	115
France	3,015	48	2	37	87	108
Germany, West	2,935	42	1	31	74	124
Greece	2,600	22	6	47	75	73
Ireland	3,375	46	1	42	89	112
Italy	2,755	27	5	46	78	73
Netherlands	2,895	43	1	28	72	119
Norway	3,180	43	1	33	77	131
Portugal	2,485	20	5	40	65	72
Spain	2,565	23	7	42	72	79
Sweden	2,935	50	1	26	77	124
Switzerland	3,040	50	1	31	82	110
United Kingdom	3,200	56	2	27	85	128
E. Europe & USSR						
Bulgaria	2,780	20	6	63	89	61
Czechoslovakia	3,010	26	1	41	68	95
Germany, East	2,950	35	1	36	72	112
Hungary	2,925	26	3	42	71	85
Poland	3,100	35	1	43	79	97
Rumania	2,790	18	3	51	72	57
Soviet Union	2,985	26	3	63	92	70
Yugoslavia	2,770	24	5	59	88	60
Africa[1]						
Algeria	2,230	15	5	39	59	28
Angola	2,215	8	17	31	56	44
Belgian Congo and Ruanda-Urundi	2,650	7	15	27	49	37
Cameroun	2,470	5	7	39	51	51
Egypt	2,340	7	12	51	70	45
Ethiopia	2,295	16	18	42	76	48
Fr. Equat. Africa	2,575	7	10	39	56	62
Fr. W. Africa excluding Guinea	2,450	5	8	46	59	27

Table A4.--Food consumption levels per person per day, in terms of calories, protein, and fat content, by countries, 1958--Continued

Country	Calories	Protein				Fat
		Animal	Pulse	Other	Total	
	Number	Grams	Grams	Grams	Grams	Grams
Africa[1]--Cont.						
Ghana	2,605	9	5	37	51	52
Guinea	2,400	4	10	33	47	60
Kenya	2,240	13	6	45	64	37
Liberia	2,540	3	3	36	42	55
Libya	2,180	8	7	41	56	38
Morocco	2,480	17	1	54	72	30
Nigeria & Br. Cameroons	2,680	6	9	45	60	49
Rhodesia & Nyasaland	2,500	12	13	51	76	46
Sudan	2,295	16	9	41	66	51
Tanganyika	2,175	9	14	41	64	26
Togo	2,645	4	10	34	48	65
Tunisia	2,170	15	4	48	67	27
Union of So. Africa	2,620	24	3	47	74	73
Asia						
Burma	2,150	10	7	34	51	26
Ceylon	2,060	8	4	34	46	59
Communist Asia[2]	2,200	6	15	44	65	32
India	2,050	6	15	36	57	34
Indonesia	2,125	4	10	34	48	38
Iran	2,040	13	4	45	62	30
Iraq	2,255	15	7	52	74	38
Israel	2,715	30	3	46	79	76
Japan	2,310	13	11	42	66	23
Jordan	2,085	8	10	45	63	37
Korea, South	2,040	11	10	39	60	19
Lebanon	2,415	14	3	55	72	46
Malaya	2,290	11	5	35	51	40
Pakistan	2,030	10	8	36	54	20
Philippines	2,145	15	4	37	56	39
Syria	2,255	11	4	50	65	40
Taiwan	2,340	12	12	36	60	37
Thailand	2,185	12	4	29	45	35
Turkey	2,650	12	6	66	84	45
Oceania[3]	3,210	67	5	31	103	136

[1] Names and frontiers as they generally existed in 1958.
[2] Communist China, North Korea, and North Vietnam.
[3] Includes Australia and New Zealand.

Source: U. S. Department of Agriculture, World Food Budget (12).

Table A5.--Expenditures for food as share of total consumption expenditure of households and private non-profit institutions, by countries, 1954-60

Country	1954	1955	1956	1957	1958	1959	1960
				-Percent-			
North America							
Canada	23.7	23.1	23.1	23.4	23.3	23.0	22.7
United States	24.4	23.2	23.2	23.0	23.2	21.9	21.5
Latin America							
Dominican Republic	50.8	49.7	52.1	51.9	52.5	51.0	--
Ecuador	48.8	48.3	49.0	45.6	44.8	44.3	43.8
Honduras	47.4	49.9	45.0	44.0	43.2	--	--
Jamaica	41.7	40.6	39.2	37.8	38.2	36.8	35.2
Panama	41.8	41.0	38.7	39.1	37.0	37.9	35.4
Peru	38.9	39.0	38.9	38.9	39.7	39.7	--
Trinidad and Tobago	37.8	37.6	38.1	37.1	36.8	36.8	--
Western Europe							
Austria	37.1	36.3	35.7	35.1	35.1	35.0	--
Belgium	29.8	29.2	29.5	28.6	29.5	28.9	28.1
Denmark	27.4	27.5	27.4	25.8	25.6	24.9	24.6
Finland	39.2	37.7	38.7	40.2	41.0	39.4	38.0
France	34.8	34.0	33.3	31.6	31.9	31.3	30.6
Greece	48.2	49.0	46.5	45.7	45.2	46.3	--
Ireland	39.1	39.2	38.5	38.9	39.4	40.2	38.2
Italy	47.2	46.8	46.7	45.8	45.6	45.2	44.7
Luxembourg	34.2	34.7	35.3	35.0	35.1	35.2	--
Netherlands	34.4	32.8	32.4	31.8	31.8	31.7	30.5
Norway	30.8	30.7	31.4	30.2	30.7	30.3	29.1
Sweden	30.0	29.8	29.9	28.7	28.2	27.3	27.3
United Kingdom	31.3	31.8	32.0	31.6	30.7	30.3	29.5
Eastern Europe							
Yugoslavia	51.7	53.2	53.0	48.3	48.3	46.5	--
Africa							
Ghana	--	52.9	54.9	55.3	54.4	54.8	54.1
Rhodesia and Nyasaland	43.3	41.9	40.5	40.2	40.6	40.5	40.2
South Africa	33.9	32.9	33.1	32.5	31.9	31.3	--
Asia							
Ceylon	54.1	53.9	53.7	55.2	53.9	52.8	51.5
China (Taiwan)	57.8	57.8	56.1	55.0	54.3	53.4	53.3
Israel	--	32.5	33.6	32.6	33.3	32.7	32.3
Japan	55.3	53.5	52.6	51.5	50.8	48.8	46.9
Korea, Republic of	49.9	49.9	54.0	58.4	53.2	49.6	50.4
Oceania							
Australia	25.7	26.0	26.1	25.3	25.4	24.8	25.0

Source: Yearbook of National Accounts Statistics, United Nations (58).

Table A6.--World barley trade: Total and net trade, by regions, averages 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61

Period and region	Total trade		Net trade	
	Exports	Imports	Exports	Imports
	1,000 metric tons			
Average, 1934-38				
North America	499	131	368	--
Latin America	391	14	377	--
Western Europe	137	2,405	--	2,268
E. Europe & USSR	965	7	958	--
Africa	220	70	150	--
Asia	410	70	340	--
Oceania	73	9	64	--
Average, 1948-52				
North America	1,443	270	1,173	--
Latin America	272	13	259	--
Western Europe	228	2,524	--	2,296
E. Europe & USSR	NA	NA	NA	--
Africa	507	27	543	--
Asia	502	740	--	238
Oceania	259	2	257	--
Average, 1957/58-59/60				
North America	3,711	335	3,376	--
Latin America	370	77	293	--
Western Europe	895	4,693	--	3,798
E. Europe & USSR[1]	662	745	--	83
Africa	220	22	198	--
Asia	437	835	--	398
Oceania	555	--	555	--
Annual 1960/61				
North America	2,647	248	2,399	--
Latin America	160	95	65	--
Western Europe	1,410	3,985	--	2,575
E. Europe & USSR[2]	413	434	--	21
Africa	115	195	--	80
Asia	35	960	--	925
Oceania	755	--	755	--

[1] 1957-59 Average. FAO Trade Yearbook. Vol. 15. 1961.
[2] Annual 1960. FAO Trade Yearbook. Vol. 15. 1961.

Source: 1934-38 data - FAO Trade Yearbook, 1958; 1948-52 data - FAO Trade Yearbook, 1960; 1957/58-59/60 and 1960/61 data - FAO World Grain Trade Statistics, 1960/61 except where otherwise indicated.

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Table A7.--World trade in millets and sorghum: Total and net trade, by regions, average 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61

Period and region	Total trade		Net trade	
	Exports	Imports	Exports	Imports
	1,000 metric tons			
Average, 1934-38				
North America	8	11	--	3
Latin America	53	2	51	--
Western Europe	9	201	--	192
E. Europe & USSR	37	10	27	--
Africa	86	42	44	--
Asia	417	345	72	--
Oceania	--	1	--	1
Average, 1948-52				
North America	1,138	9	1,129	--
Latin America	85	4	81	--
Western Europe	14	823	--	809
E. Europe & USSR	NA	NA	--	--
Africa	93	19	74	--
Asia	156	598	--	442
Oceania	53	--	53	--
Average, 1957/58-59/60				
North America	1,991	15	1,976	--
Latin America	240	38	202	--
Western Europe	50	2,107	--	2,057
E. Europe & USSR[1]	10	15	--	5
Africa	157	60	97	--
Asia	58	353	--	295
Oceania	52	--	52	--
Annual 1960/61				
North America	2,199	14	2,185	--
Latin America	220	80	140	--
Western Europe	37	2,015	--	1,978
E. Europe & USSR[2]	11	38	--	27
Africa	240	100	140	--
Asia	45	400	--	355
Oceania	10	--	10	--

[1] 1957-59, Average. FAO Trade Yearbook. Vol. 15, 1961.
[2] Annual 1960. FAO Trade Yearbook. Vol. 15, 1961.

Source: 1934-38 data - FAO Trade Yearbook, 1958; 1948-52 data - FAO Trade Yearbook, 1960; 1957/58-59/60 and 1960/61 data - FAO, World Grain Trade Statistics 1960/61.

Table A8.--World oats trade: Total and net trade, by regions, average 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61

Period and region	Total trade		Net trade	
	Exports	Imports	Exports	Imports
	1,000 metric tons			
Average, 1934-38				
North America	182	91	91	--
Latin America	424	19	405	--
Western Europe	48	730	--	682
E. Europe & USSR	174	3	171	--
Africa	39	19	20	--
Asia	19	10	9	--
Oceania	6	1	5	--
Average, 1948-52				
North America	756	493	263	--
Latin America	185	29	156	--
Western Europe	59	773	--	714
E. Europe & USSR	NA	NA	--	--
Africa	37	15	22	--
Asia	7	11	--	4
Oceania	190	--	190	--
Average, 1957/58-59/60				
North America	708	142	566	--
Latin America	347	45	302	--
Western Europe	139	1,272	--	1,133
E. Europe & USSR[1]	239	144	95	--
Africa	15	5	10	--
Asia	10	5	5	--
Oceania	195	--	195	--
Annual 1960/61				
North America	424	18	406	--
Latin America	225	65	160	--
Western Europe	115	1,065	--	950
E. Europe & USSR[2]	42	63	--	21
Africa	15	5	10	--
Asia	5	85	--	80
Oceania	350	--	350	--

[1] 1957-59 average. FAO Trade Yearbook. Vol. 15. 1961.
[2] Annual 1960. FAO Trade Yearbook. Vol. 15. 1961.

Source: 1934-38 data - FAO Trade Yearbook, 1958; 1948-52 data - FAO Trade Yearbook, 1960; 1957/58-59/60 and 1960/61 data - FAO, World Grain Trade Statistics, 1960/61.

Table A9.--World rye trade: Total and net trade, by regions, average 1934-38, 1948-52, 1957/58-59/60 and annual 1960/61

Period and region	Total trade		Net trade	
	Exports	Imports	Exports	Imports
	1,000 metric tons			
Average, 1934-38				
North America	83	109	--	26
Latin America	116	--	116	--
Western Europe	98	807	--	709
E. Europe & USSR	666	56	610	--
Africa	1	--	1	--
Asia	21	5	16	--
Oceania	--	--	--	--
Average, 1948-52				
North America	344	110	234	--
Latin America	168	1	167	--
Western Europe	102	894	--	792
E. Europe & USSR	NA	NA	--	--
Africa	3	1	2	--
Asia	19	7	12	--
Oceania	--	--	--	--
Average, 1957/58-59/60				
North America	269	93	176	--
Latin America	157	--	157	--
Western Europe	138	627	--	489
E. Europe & USSR[1]	489	431	58	--
Africa	--	--	--	--
Asia	22	2	20	--
Oceania	--	--	--	--
Annual 1960/61				
North America	292	68	224	--
Latin America	110	--	110	--
Western Europe	350	700	--	350
E. Europe & USSR[2]	714	540	174	--
Africa	--	20	--	20
Asia	20	--	20	--
Oceania	--	--	--	--

[1] 1957-59 Average. FAO Trade Yearbook. Vol. 15. 1961.
[2] Annual 1960. FAO Trade Yearbook. Vol. 15. 1961.

Source: 1934-38 data - FAO Trade Yearbook, 1958; 1948-52 data - FAO Trade Yearbook, 1960; 1957/58-59/60 and 1960/61 data - FAO, World Grain Statistics 1960/61.

Table A10.--Consumption of commercial nitrogenous fertilizer, by regions, 1938, 1950/51, and 1960/61

Region	1938	1950/51	1960/61
	---1,000 metric tons of N---		
Geographic regions			
North America	339	1,199	2,798
Latin America	41	121	482
Western Europe	1,077	1,584	3,146
E. Europe and USSR	448	374	1,723
Africa	100	150	310
Asia[1]	500	650	1,690
Oceania	30	20	30
World	2,535	4,098	10,179
Economic regions			
Developed regions	1,894	3,177	7,697
Less developed regions	[1] 641	[1] 921	[1] 2,482
Political regions			
Free World	2,087	3,724	8,456
Communist Bloc	[1] 448	[1] 374	[1] 1,723

[1] Excludes Mainland China but amount of fertilizer used by this country is not large relative to the regional total.

Source: FAO Production Yearbooks. (15) except Soviet Union data for 1938 and 1950/51 which are U.S. Dept. Agric. data.

Table All.--Consumption of commercial phosphate fertilizer, by regions, 1938, 1950/51, and 1960/61

Region	1938	1950/51	1960/61
	- - - -1,000 metric tons P_2O_5- - -		
Geographic regions			
North America.....	706	2,133	2,627
Latin America.....	30	117	263
Western Europe.....	1,656	2,337	3,525
E. Europe and USSR.....	867	735	1,595
Africa.....	80	180	320
Asia[1].....	390	300	840
Oceania.....	330	490	800
World.....	4,059	6,282	9,970
Economic regions			
Developed regions.....	3,559	5,695	8,547
Less developed regions....	[1] 500	[1] 597	[1] 1,423
Political regions			
Free World.....	3,192	5,557	8,375
Communist Bloc.....	[1] 867	[1] 735	[1] 1,595

[1] Excludes Mainland China but amount of fertilizer used by this country is not large relative to the regional total.

Source: FAO Production Yearbooks. (15) except data for Soviet Union in 1950/51 which are U.S. Dept. Agr. data. Agr. data.

Table A12.--Consumption of commercial potash fertilizer, by regions, 1938, 1950/51 and 1960/61

Region	1938	1950/51	1960/61
	1,000 metric tons of K_2O		
Geographic regions			
North America	371	1,368	2,116
Latin America	11	52	254
Western Europe	1,386	2,146	3,327
E. Europe and USSR	883	826	1,809
Africa	20	30	90
Asia[1]	140	120	760
Oceania	20	20	100
World	2,831	4,562	8,456
Economic regions			
Developed regions	2,660	4,360	7,352
Less developed regions	[1] 171	[1] 202	[1] 1,104
Political regions			
Free World	1,948	3,736	6,647
Communist Bloc	[1] 883	[1] 826	[1] 1,809

[1] Excludes Mainland China but amount of fertilizer used by this country is not large relative to the regional total.

Source: FAO Production Yearbooks. (15) except data for Soviet Union for 1938 and 1950/51 which was supplied by the U.S. Dept. Agr.

Table A13.--Per capita annual grain production, net trade and availability by regions, average 1934-38, 1948-52, 1957/58-59/60 and 1960/61[1]

Region	1934-38	1948-52	1957/58-59/60	1960/61
	Kilograms			
Geographic region				
North America				
Production	768	1,006	1,042	1,107
Net trade	-37	-139	-166	-200
Availability	731	867	876	907
Latin America				
Production	254	190	213	214
Net trade	-74	-5	-5	+2
Availability	180	185	208	216
Western Europe				
Production	247	234	284	293
Net trade	+88	+79	+76	+84
Availability	335	313	360	377
E. Europe & USSR				
Production	533	[2] 453	535	558
Net trade	-16	NA	+1	-1
Availability	517	NA	536	557
Africa				
Production	158	161	167	170
Net trade	-4	+2	+5	+9
Availability	154	163	172	179
Asia				
Production	231	197	221	226
Net trade	-2	+4	+6	+10
Availability	229	201	227	236
Oceania				
Production	455	538	467	688
Net trade	-252	-265	-187	-372
Availability	203	27	280	316
Economic regions				
Developed reg's				
Production	470	497	559	593
Net trade	+15	-5	-14	-24
Availability	485	492	545	569
Less developed reg's				
Production	224	192	214	218
Net trade	-8	+2	+5	+9
Availability	216	194	219	227
Political regions				
Free World				
Production	278	275	301	319
Net trade	+2	+1	([3])	-2
Availability	280	276	301	317
Communist Bloc				
Production	359	301	345	345
Net trade	-4	-1	+1	+3
Availability	355	300	346	346

[1] Plus sign = net imports; minus sign = net exports.
[2] Excludes Soviet Union
[3] Less than 0.5 Kilograms

Source: Earlier tables on production and trade.

Table A14.--Annual grain production, net trade and availability, by regions, average 1934-38, 1948-52, 1957/58-59/60 and 1960/61[1]

Region	1934-38	1948-52	1957/58-59/60	1960/61
	Million metric tons			
Geographic regions				
North America				
Production	109	169	199	218
Net trade	-5	-23	-32	-39
Availability	104	146	167	179
Latin America				
Production	31	31	42	44
Net trade	-9	-1	-1	(2)
Availability	22	30	41	44
Western Europe				
Production	67	65	84	88
Net trade	+24	+22	+22	+25
Availability	91	87	106	113
E. Europe and USSR				
Production	153	134	177	189
Net trade	-5	NA	(2)	(2)
Availability	148	NA	177	189
Africa				
Production	26	32	38	40
Net trade	-1	(2)	+1	+2
Availability	25	32	39	42
Asia				
Production	260	272	348	366
Net trade	-2	+6	+10	+16
Availability	258	278	358	472
Oceania				
Production	5	7	7	11
Net trade	-3	-3	-3	-6
Availability	2	4	4	5
Economic regions				
Developed regions				
Production	334	375	467	506
Net trade	+11	-4	-13	-20
Availability	345	371	454	486
Less developed regions				
Production	316	334	428	450
Net trade	-11	+4	+13	+20
Availability	305	338	441	470
Political regions				
Free World				
Production	384	452	562	613
Net trade	+3	+1	-1	-3
Availability	387	453	561	610
Communist Bloc[3]				
Production	266	257	333	343
Net trade	-3	[4]-1	[4]+1	[4]+3
Availability	263	256	334	346

[1] Plus sign = net imports; minus sign = net exports. [2] Less than 500,000 metric tons. [3] Cuba not included. [4] Although complete data on net trade for the Bloc countries are not available for this period, net imports are assumed equal to the net exports of the Free World.

Source: Earlier tables on production and trade.

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